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A Cost-Effectiveness Analysis of Early Literacy Growth in Public Pre-Kindergarten
Programs

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor
of Philosophy at Virginia Commonwealth University.

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Abstract**A COST_EFFECTIVENESS ANALYSIS OF EARLY LITERACY GROWTH IN PUBLIC PRE-KINDERGARTEN**

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

Virginia Commonwealth University, 2020

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Student early literacy readiness is predictive of later academic success and pre-k programs are a proven intervention to develop early literacy; however, the cost of pre-k programs differs greatly. These differences in cost are related to the opportunities and services included within each program. This study examined four pre-k programs offered within a large school system in Virginia to determine if there were differences in students' early literacy growth by program attended and evaluated the ratio of cost to achievement of each pre-k program to determine their cost-effectiveness. To do this, two one-way analyses of variances (ANOVAs) were conducted to test if the pre-k program attended had an effect on students' early literacy performance. Student performance was measured using data from the Fall 2017 and Spring 2018 PALS-Pre-K administrations. ANOVAs were conducted using mean gain scores and developmental level attainment measures. The cost of each program was then determined using an

ingredients method. Financial data was collected through a review of financial documents and interviews. Finally, three Cost-Effectiveness Ratios were calculated using mean gain scores, developmental range attainment, and a standardized mean gain score. Results found no significant differences between group means [$F(3, 509) = .636, p = .592, \eta^2 = .004$ and $F(3, 510) = .329, p = .804, \eta^2 = .002$]. A comparison of mean gain scores revealed a 4.60-point difference across the programs, suggesting that early literacy performance between programs does not differ greatly within the population studied. In the overall mean developmental range attainment analysis, a difference of only .08 was found between programs, again demonstrating that there was not much variance between programs. Although this study did not find significant differences in students' early literacy performance between pre-k programs, this study did reveal significant differences in the overall costs of pre-k programs studied. CEA results found the Title I Pre-K program to be the most cost-effective, lowest cost with highest gains. These findings do not consider longer-term benefits or benefits related to potential effects on other school readiness factors.

Chapter 1: Introduction

For more than 50 years, publicly funded pre-kindergarten (pre-k) programs have been touted as a solution to close racial and socio-economic academic achievement gaps within the American public education system. Since 1964, political sentiment has regarded early intervention, such as quality pre-k programs, as essential to “breaking the cycle of poverty.” Following President Lyndon B. Johnson’s 1964 *State of the Union Address* where “The War on Poverty” was formally declared, Sargent Shriver, serving as the director of the Office of Economic Opportunity, assembled a panel of experts to develop a pre-k early intervention initiative, focused on helping communities meet the needs of their children identified as *at-risk* (History of Head Start, 2017). These experts, chaired by Dr. Robert Cooke, a professor of pediatrics and former Pediatrician in Chief at Johns Hopkins, based their work on research supporting the theory that children identified as at-risk reach school age lacking school readiness skills and that early intervention is critical to interrupting the cycle of poverty perpetuated by various risk factors.

This study chooses to maintain the use of the term at-risk as written when in direct relation to the intended historical reference while minimizing the descriptor elsewhere. The original context of the term at-risk is a broadly defined group of children who are considered at a higher risk than their peers of dropping out of school due to poverty, disabilities, family educational attainment, health, English language proficiency, family incarceration, etc. (Glossary of Educational Reform, 2013). Generally, the term at-risk has included a higher majority of students of nonwhite origins. Within educational research, the use of the construct of at-risk is outdated as it

is seen as biased, derogatory, and stigmatizing. Because of the degrading nature of the term at-risk, this study seeks to reduce the use of the term outside of referencing historical representations of its use. It should be noted that this study does not judge the previous use of the term as the appropriateness of descriptors change as societal norms evolve. When possible, students, students with risks, or students identified with risks will be used instead of at-risk. Furthermore, when possible, the risk factors will be specifically identified.

The benefits of early intervention have been supported by multiple studies on the effects of early education for children coming from socially and economically disadvantaged situations. Various longitudinal studies provide support that early education results in benefits stretching into secondary schooling and beyond (Schweinhart, 1993; Schweinhart, 2004), albeit some research on the longer-term effects have proven less conclusive (U.S. Department of Health and Human Services, 2010). Overall, research on the correlation between early literacy skills and later academic performance is positive (Judge, 2013) and supports the continued study and implementation of interventions like pre-k that further prepare children for the formal years of school.

Originally designed as part of the efforts to help break the cycle of poverty (Office of Head Start, 2017), publicly funded pre-k programs have sought to provide preschool aged children identified with risks with emotional, social, health, nutritional, and psychological supports and opportunities (Office of Head Start, 2017). Over the years, the mission of pre-k programs in the United States has expanded to include the development of academic school-readiness skills. The rationale for this expansion is

based on findings suggesting that students with risks come to school lacking school readiness skills and that achievement gaps can be mitigated with early intervention prior to students attending traditional K-12 schooling. Chatterji's (2006) research with first grade students found that reading achievement is associated with students' school-readiness skills, specifically with students' reading readiness. Furthermore, Chatterji (2006) found that students identified with risks had the lowest levels of reading skills of all students entering first grade.

Similarly, in their study comparing grade repetition and early literacy performance of children attending a state-funded pre-k program, like the Virginia Preschool Initiative (VPI), against children that did not attend a pre-k program, Huang, Invernizzi, and Drake (2011) found that students attending VPI were less likely to be retained in kindergarten and had higher performance in the area of literacy skills than students who did not attend pre-k. These differences were the most significant among students identifying as Black or Hispanic (Huang et al., 2011). Based on findings like these, various states, Virginia included, have implemented robust pre-k initiatives to assist in mitigating opportunity and achievement gaps that are continually spotlighted in the present high stakes standardized testing and accountability environment.

Pre-K Programs in the Commonwealth of Virginia

As of 2016, Virginia ranked 29th in the nation for access to publicly funded pre-k programs (Barnett, 2016), with the primary explanation for the lower rating being related to matching local funding requirements included in the various funding allocations. In 2018, *US News* reported Virginia as 24th in the nation for pre-k enrollment. Much of this increased access can be attributed to the continuation of federal and state funded pre-k

programs, like Head Start and the Virginia Preschool Initiative (VPI), and the expansion of an enhanced Virginia Preschool Initiative Plus (VPI+) program.

From Fall 2016 until the Spring of 2019, there were four public pre-k programs funded across the Commonwealth of Virginia: Head Start, Title I funded classes, the Virginia PreSchool Initiative (VPI), and the Virginia PreSchool Initiative Plus (VPI+). These programs share in their mission of closing school readiness and achievement gaps between various groups of students but vary in structure and content. Virginia's programs are different from one another in a variety of ways: inclusion of professional development opportunities, teacher coaching, the use of specific research-based curricula, and the inclusion of wrap-around services. Different content and structure have implications on the costs of providing pre-k programs. At the time of this study, there were no studies comparing the four publicly funded pre-k programs' early literacy performance to overall program costs.

This study focuses on the early literacy skills growth of students within the four pre-k programs offered across Virginia during the 2017-2018 school year. While this study is not intended to identify or determine the individual effects of specific factors within each pre-k program, amount of professional development, the use of research-based curriculum, or the inclusion of nutrition, medical, and other wellness associated services, each of these supports come at a cost. Therefore, these differences directly relate to the purpose of this study, which is to determine the early literacy growth of students in relation to the per pupil cost of the implementation of each of the pre-k programs. To do this, a brief overview of each of the pre-k programs is helpful to assist

in differentiating the instructional approaches and supplemental services influencing overall costs.

Head Start. The origins surrounding the development of the federally funded Head Start program stem from the recommendations of a panel of “experts” convened following President Lyndon B. Johnson’s 1964 declaration of “The War on Poverty” during a *State of the Union Address*. Among other things, the panel recommended the immediate creation of a comprehensive child development program that is specific to the communities in which the program serves. The inclusion of medical, nutritional, social, and general education services with the ability to address the needs of the whole child was embraced by this recommendation (History of Head Start, 2017; U.S Department of Health, Education, and Welfare, 1972). Furthermore, this recommendation was supported by research on the effects of poverty and the ability of education to mitigate the negative effects of poverty (History of Head Start, 2017; U.S Department of Health, Education, and Welfare, 1972). As intended by the panel, “Head Start was designed to help break the cycle of poverty, providing preschool children of low-income families with a comprehensive program to meet their emotional, social, health, nutritional and psychological needs” (History of Head Start, 2017, p. 2).

As the longest operating publicly funded pre-k program, there is considerable longitudinal data about the effects of the Head Start program. The largest and most comprehensive of these studies is the *Head Start Impact Study* (2010). As a brief overview, this large nationally representative study found positive effects on school readiness, specifically in the areas of language and literacy, and inconclusive

diminishing longer-term academic impacts related to students' later academic achievements as they progressed through formal K-12 education.

Title I Pre-K. Little is written on the impacts of Title I Pre-K programs in isolation. The US Department of Education has published non-regulatory guidance in regards to how to use Title I funds for the purposes of providing preschool opportunities. The most recent guidance is in the form of a 37-page document that does not “impose any regulations beyond those required under the applicable law and regulations” (USDOE, 2012, p. 1). This guidance, last published in October 2012, pertains more to ensuring that funding is in compliance with regulations outlined within Title I and not with the specific operations of the pre-k program itself. This guidance document does provide a broad overarching definition of a Title I preschool program as: “a preschool program for which a Local Education Agency (LEA) or school uses Title I funds, in whole or in part, to improve cognitive, health, and social-emotional outcomes for eligible children below the grade at which a LEA provides a free public elementary education” (USDOE, 2012, p. 3). The language within this definition provides evidence to the Head Start lineage of the philosophy and structure of Title I Pre-K programs.

Reviewing school district websites, Title I guidance documents, and the published research, it is evident that much is left to the individual school systems in the implementation and evaluation of Title I Pre-K programs. For instance, starting in the 2002-2003 school year Charlotte-Mecklenburg began using large sums of allocated Title I funding to implement a preschool initiative named Bright Beginnings. Internal evaluations of this Title I Pre-K program have found that first grade students who participated in Bright Beginnings outperformed students who were eligible, but did not

participate in the program, in the areas of recognizing letters, counting numbers, socialization, and classroom participation (Jacobson, 2001). Similarly, achievement tests of students in California who participated in South Bay Union's Title I funded pre-k program, VIP Village, demonstrated higher performance than their same aged peers (Jacobson, 2001).

While the above evaluations of Title I Pre-K programs are positive, these are internal evaluations of programs with limited information on the design of the studies. Performance of Title I Pre-K programs as a whole are difficult, if not impossible, to discern because of inconsistencies in the pre-k programs' requirements and implementations and because of the rigor of the research designs used in the limited evaluations that do exist. Because of the above stated, individual performance of Title I funded pre-k programs can be assumed to resemble the pre-k programs that they most mirror in implementation, funding, and quality.

Title I Pre-K classes look different depending upon the school system in which they reside. Some classes more closely resemble Head Start programs while other programs more closely resemble VPI or VPI+. Each school system has differing requirements surrounding the implementation and operation of Title I Pre-K programs. The school system in this study began attempting to standardize pre-k programs as much as possible during the 2018-2019 school year. Examples of this standardization attempt include a concerted effort to provide comparable or shared professional development opportunities, the use of a shared curriculum, the use of similar formative, summative, and growth assessments, and the creation of a collaborative single source registration process.

Virginia Preschool Initiative. In 1994, the *Legislative Commission on Equity in Public Education* recommended the creation of a state-funded, preschool program for at-risk four-year-old students to the Virginia General Assembly (VDOE, 2015). The legislative intent of the initiative was to further expand quality preschool education programs by distributing state funds to schools and community-based organizations for at-risk four-year-old children not served by Head Start (VDOE, 2017). Since its establishment in 1996, multiple comprehensive studies have evaluated the Virginia Preschool Initiative (VPI).

In 2007, the Virginia General Assembly directed The Joint Legislative Audit and Review Commission (JLARC) to review the Virginia Preschool Initiative's (VPI) costs, implementation, and effectiveness. Within this review, the commission found that VPI students outperformed other kindergarten students on the Fall Kindergarten Phonological Awareness Literacy Screening (PALS). The commission also reiterated their belief that quality preschool experiences help prepare students with risks for school, emphasizing that the benefits can be long-lasting. These findings were reaffirmed by the commission's Virginia Preschool Initiative Joint Subcommittee in a 2015 report (*Virginia Preschool Initiative (VPI): Current Implementation and Potential Changes*, 2015). Evaluations of the VPI program suggest that students participating in a VPI program make gains in early literacy skills exceeding that of their peers not enrolled in a pre-k program.

Virginia Preschool Initiative Plus. As part of the United States Department of Education's Preschool Development Grant (PDG), Virginia was one of 13 states awarded a four-year preschool expansion grant to improve upon an existing pre-k

program, in this case VPI, and to increase access to high quality pre-k services (VDOE, 2017). School divisions selected to participate were selected based upon poverty levels, the total number of Title I schools, kindergarten literacy readiness scores, and the number of unserved four-year-old children identified with risks within other pre-k programs (VDOE, 2016).

Virginia was awarded 70 million dollars in 2014, paid out over four years, to expand upon the VPI program. This expanded and enhanced pre-k program was known as the Virginia Preschool Initiative Plus (VPI+). VPI+ increased the pre-k slots available for four-year-old students by more than 13,000 across the state over a four-year period. Students qualifying for participation were those deemed at-risk primarily determined by annual income (VDOE, 2016).

The mission of the VPI+ program was to increase pre-k enrollment across the Commonwealth of Virginia by developing a statewide infrastructure of supports, which included research-based curriculum, increased quality professional development, and standardized formative assessments (Allan & Hamre, 2016). Initial data from the first two years of implementation demonstrated statistically significant gains in all six areas of literacy skills measured on the PALS (Allan & Hamre, 2016). The six literacy skills referenced and considered to be foundational skills by the Virginia Department of Education (VDOE) for reading development were: alphabet recognition, beginning sound awareness, name writing, print/word awareness, rhyme awareness, and nursery rhyme awareness. In addition to the PALS data, parent survey results reported 93% of families surveyed noticed improvement in their child's pre-reading and letter names

skills, and that 95% observed improvement in their child's overall vocabulary and communication skills (Allan & Hamre, 2016).

Significance of the Research

If early literacy and readiness skills are associated with improved academic performance throughout the formal years of schooling, as the literature supports, and knowing that participation in pre-k has been proven to improve early literacy skills, it is critical to maintain pre-k initiatives like the four discussed in this study. Early intervention prepares students for the rigors of public schooling, decreasing the need for later academic intervention of students struggling to attain achievement benchmarks and growth. Research suggests that quality pre-k programs are more cost-effective than long-term k-12 interventions like special education, remedial coursework, and grade level retention. Research also suggests a long-term cost savings to society. In this case, costs to society may be considered the loss of opportunity costs like higher wages and higher standards of living overall or the costs related to lower standards of living like those associated with increased crime and decreased health.

The VDOE asserts that the early childhood programs offered in Virginia provide the foundation for learning and academic success. This study seeks to use a large school system in Virginia as a case study to examine if there are differences in students' early literacy skills growth by program participation and, since funding is not infinite, to evaluate the ratio of cost to achievement of each pre-k program. The use of the word case study in this situation is not linked to the methodology of the study. This non-experimental cost-analysis is focused on students' early literacy growth and the cost of each program to achieve early literacy outcomes. At the time of the conceptualization of

this study, there were vast disparities in the funding of the four programs offered across Virginia during the 2017-2018 school year. Since the 2017-2018 school year there have been some local and state attempts to address these disparities. Findings from this study may be used to inform practice within the school system studied and may have broader policy implications on the programs being promoted and funded at the state and national levels.

This research is timely as grant funding for the VPI+ expansion grant, the most recent iteration of pre-k reform and expansion in Virginia, expired at the end of the 2018-2019 school year leaving the fate of the VPI+ classrooms up to individual school systems. The school system within this study elected to fold the VPI+ pre-k classes into the VPI program. This appears to be a common practice across the Commonwealth and in line with the intentions of the VPI+ grant to expand access to pre-k. Additionally, in November of 2018, Governor Ralph Northam announced the establishment of a Children's Cabinet to assist in prioritizing issues like school readiness (Executive Order No. 11, 2018). Within this Executive Order (2018), it was formally acknowledged that educational success begins long before students enter formal K-12 schooling and that early education is a worthy investment in creating and maintaining a strong future workforce. This combination of political desire and the expiration of significant pre-k funding is an opportune time to consider the costs, performance, and value of pre-k programs in Virginia. Results from this study will be shared with the school system involved in hopes of aiding future decisions pertaining to pre-k program offerings and may be helpful to other school systems and governmental entities in their prioritization of funding and implementation of early intervention initiatives.

A Brief Review of the Literature

Pivotal pre-k studies and evaluations of pre-k programs (JLARC, 2007; Schweinhart, 1993; Schweinhart, 2004; U.S. Department of Health and Human Services, 2010) establish that quality pre-k experiences increase formal school readiness, specifically in the areas of early language, literacy, and mathematical development (JLARC, 2007; Phillips, Lipsey, Dodge, Haskins, Bassok, Burchinal, Duncan, Dynarski, Magnuson, and Weiland, 2017). There is some debate over the longer-term effects of pre-k programs (U.S. Department of Health and Human Services, 2010); however, recent research on the inclusion of more focused structural interventions and quality-supports like the implementation of research-based curricula, increased teacher professional development, and teacher coaching, yields positive longer-term effects. Positive effects have been noted on IQ scores, student achievement test scores (Weiland and Yoshikawa, 2013), grade repetition, special education identification, high school graduation, and delinquency (JLARC 2007) with the highest effects for those students labeled as at-risk.

Since its inception, the immediate and short-term effects of publicly funded pre-k programs have been recognized and supported by a large body of research; this is particularly true for children coming from socially and economically disadvantaged situations (JLARC, 2007). Additionally, various longitudinal studies have supported continued benefits into secondary schooling and beyond (Schweinhart, 1993; Schweinhart, 2004). Reviewing the most recent updates to *The High/Scope Perry Preschool study* (2004) and the *Head Start Impact Study* (2010), as well as considering student performance within program evaluations of the VPI and VPI+ programs,

provides a balanced overview of the agreed upon short-term effects and the diverging findings of the longitudinal impacts.

Methodology

A cost-effectiveness analysis (CEA) was conducted to determine the cost-effectiveness of the four pre-kindergarten programs as they relate to students' early literacy skills growth. CEAs are used to compare programs by analyzing the overall costs of the programs to the extent of achieved results on a common measure (Boardman, Greenberg, Vining, and Weimer, 2011, Chapter 18; Levin, McEwan, Belfield, Bowden, and Shand, 2018). This study used the early literacy skills growth of students within four distinct pre-k programs as the common measure of performance to determine effectiveness.

When conducting CEAs, programs being compared must have a common goal. In this case, the common goal was the academic achievement in the form of early literacy performance measured by growth on the Phonological Awareness Literacy Screening (PALS). For this study the cost-effectiveness analysis using PALS data as a growth measure followed these steps:

1. The cost of each intervention was determined using an ingredients method, a method that lists all costs of an intervention much like a shopping list. Benefits of the ingredients' method include transparency and ease of understanding. In using this method, costs are transparent and easy to interpret.
2. An analysis of the PALS pretest/posttest early literacy gains of students in all four programs was conducted. Multiple statistical approaches were used to analyze the mean gain scores and developmental range increases between programs.

3. The Cost-Effectiveness ratio (C/E) was calculated - In this case, the C/E ratio represents the monetary cost necessary to attain an increase in mean gain scores and an increase in developmental ranges of below, on, and above using the PreK PALS.

The use of a CEA provides the Local Educational Agency (LEA) information to best make decisions about the effectiveness of the various pre-k programs compared to the overall costs with the most preferable allocation of funding being those that show the lowest cost for any given increase in the selected effect. This information should help provide context to support budgeting decisions and the allocation of funding for school systems.

Research Questions

1. Are there differences in students' PALS growth based upon the pre-k program attended?
2. What is the cost of delivering pre-k education by program?
3. What is the cost-effectiveness, as measured by early literacy growth, of pre-k programs offered within the school system being studied?

Chapter 2: Review of the Literature

The Virginia Department of Education (VDOE) asserts that early childhood programs provide a foundation for learning and academic success (VDOE, 2016). This assertion is supported by evidence demonstrating that children who attend quality pre-kindergarten (pre-k) programs, versus children who do not, have increased school readiness skills in the areas of early language, literacy, and mathematical development (Joint Legislative Audit and Review Commission [JLARC], 2007; VDOE, 2016); this is further supported by findings from various longitudinal studies and program evaluations (*Head Start Impact Study*, 2010; Schweinhart, 2004). More specifically for the purposes of this study, results have supported a positive correlation between early literacy skills and later academic success (Judge, 2013). This correlation is most pronounced among students identified as *at-risk*¹, typically meaning students who come from socio-economic backgrounds at or below the poverty level, a group that often disproportionately and predominantly includes students of color.

This review of the literature explores the research on the importance of early literacy skills development, digs deeper into the performance of pre-kindergarten programs in improving early literacy skills, and examines the current use of economic evaluation models, like cost-benefit analysis (CBA) and cost-effectiveness analyses (CEA), within the educational decision-making process. Information presented in this review is relevant to the development of educational policy and to Local Education Authorities (LEA) making decisions related to financial allocations pertaining to the

¹ As mentioned in Chapter 1, this study has attempted to maintain the use of the term *at-risk* as written when in direct relation to the intended historical reference while minimizing the use of the descriptor elsewhere.

implementation of cost-effective programs. Information found in this review can assist LEAs in considering the costs and effects of pre-k programs on early literacy attainment, a practice that has been demonstrated to assist in closing academic performance gaps between students on opposing ends of the socio-economic continuum. Most educational practices have a cost associated with them; quality pre-k programs are no different. Therefore, the following review seeks to explore not only the value of quality pre-k programs but the cost-efficiency of such programs in their development of early literacy skills in pre-k students.

The Importance of Early Literacy Skills Development

School readiness skills are those deemed necessary for a student's success upon entering formal schooling in kindergarten and continuing into later years (VDOE, 2017). One of the most substantial components of these skills is emerging literacy. Emerging literacy skills are defined by the VDOE as students: showing interest in and interacting with books as they are read by adults; answering questions about books read aloud; learning to use new words and tell stories; recognizing and producing speech sounds; identifying the letters of the alphabet; learning about print concepts from books and environmental print; engaging in drawing and pretend writing; and various beginning writing skills such as the writing of one's name, letters, and other printed symbols (VDOE, 2017).

It is well documented that students enter school with varying levels of early literacy readiness and that students coming from lower socio-economic households enter kindergarten less prepared than their more affluent peers. Chatterji's (2006) analysis of the Early Childhood Longitudinal Study (ECLS) concluded that disparities in

kindergartener's early literacy skills are closely associated with a child's poverty level and prior reading preparation, accounting for as much as 38% of the variance in reading performance. Because early literacy readiness skills are so closely associated with future academic performance, these students often exhibit achievement below their more affluent peers.

There is strong evidence that pre-k programs have positive effects on students' early literacy growth, as well as other areas, but they are expensive to implement and maintain. Therefore, their implementation and continuation are dependent upon the value LEAs and their constituents place upon them. LEAs must consider their value related to a host of other competing priorities and programs. This review of the literature explores the historical context and performance of some of the most significant pre-k programs across the nation, reviewing foundational studies and regional legislative program evaluations, to provide a contextual framework for the use of a cost-effectiveness analysis on the early literacy growth of the four pre-k programs offered across Virginia. Many of these studies include longitudinal cost-benefit analyses and demonstrate substantial benefits to society.

Pre-Kindergarten Findings

As stated in the previous chapter, the immediate and short-term benefits of publicly funded pre-k programs have been recognized and supported by a large body of research; findings are particularly strong as they relate to benefits among socially and economically disadvantaged children (JLARC, 2007). The following section examines some of the most pivotal of these pre-k studies (*The High/Scope Perry Preschool Study*, 1962-1967; *The Abecedarian Project*, 1972-1977; the *Head Start Impact Study*, 2010)

and the evaluations of two of the most prominent pre-k programs (VPI, 2007; VPI+, 2016) offered in the Commonwealth of Virginia. This review provides context for a cost-effectiveness analysis examining early literacy growth, as measured by the Phonological Awareness Literacy Screening (PALS), of students participating in one of the four pre-k programs offered within a large Virginia school system.

The High/Scope Perry Preschool Study. *The High/Scope Perry Preschool Study* is one of the most significant longitudinal preschool studies conducted to date. From 1962 through 1967, one hundred twenty-three students, all low-income African-American children, were randomly assigned to one of two groups. These groups consisted of 58 students receiving high-quality pre-k for two years, ages 3 and 4, and 65 students receiving no preschool. The high-quality preschool treatment was defined as two and a half hours of instruction daily during the school year in addition to weekly home visits. The curriculum used within this pre-k program included cognitive and socio-emotional components and was developed using the theories of Piaget, Vygotsky, and Dewey as a foundation. This theoretical framework supported the education of the “whole child,” socially, emotionally, and academically, and encouraged the inclusion of active learning lesson designs (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010).

Unique to this study, results have been followed across the participants’ lifespans with data collected at ages 3 through 11 and then again at ages 14, 15, 19, 27, and 40. A follow up is planned on age 50 data. In addition to these follow ups, there have been multiple reevaluations and analyses of the program (Heckman et al., 2010). While there have been some critiques of the study pertaining to the small sample size, the randomization process, adjustments made to the sample following the random

assignment of participants, and the reporting of results minus a thorough sensitivity analysis (Hanushek and Lindseth, 2009), reanalyzed results continue to support the benefits of high-quality preschool programs. This is especially true for students identified as at-risk (Heckman, et al, 2010), albeit at a much lesser rate than initial findings as discussed later in this section.

Schweinhart (2004) and Heckman et al. (2010) found numerous positive findings within the *High/Scope Perry Preschool Study*; statistically significant results were found between students who participated in the intervention and students who did not in the broad areas of education (HS completion rate comparisons 77% vs 60%), economic performance (median incomes: \$20,800 vs \$15,300; home ownership 27% vs 5%, automobile ownership 82% vs 60%), self-reported crime prevention (fewer overall arrests 30% vs 46% and fewer male arrests 33% vs 60%) to name a few. Schweinhart concluded his 2004 summary of the age 40 *High/Scope Perry Preschool Study* update by stating unequivocally that “high-quality” pre-k programs contribute to the academic success of at-risk students. This can be seen from the shared findings above; with the most sizable economic findings associated with crime prevention and in the benefits of crime reduction to the society as a whole, findings not necessarily associated with specific academic results.

A 2006 cost-benefit analysis follow up (Belfield, Nores, Barnett, and Schweinhart; 2006) on the age-40 data calculated a cost-benefit return to society of \$341,732 (2013 dollars) per participant on an initial investment of \$20,019, this equates to \$17.01 for every \$1 of investment. It should be noted that in this analysis, 93% of the public return (80% of the overall return) was contributed to proposed crime reduction rates for males

who participated in the program (Schweinhart, 2013). Heckman et al.'s (2010) reanalysis of Schweinhart's data found a \$7 benefit to society for every \$1 invested, a positive yet significantly lower return. Adjusted return rates were related to economic adjustments to local and regional valuations as opposed to national valuations. While lower, this return remains above historical economic equity returns of 5.8% (Heckman et al., 2010) which is still a significant return on investment.

The search by Heckman for a methodological approach for evaluating research findings on the effects of an identified program with multiple outcomes when there were concerns related to the randomization of participants led to the reanalysis of Schweinhart's *High/Scope* findings (Heckman et al., 2011). Heckman believed that his newly developed methodological approach for evaluating the strength of inferences found within studies using imperfect randomization was easier to understand in context. Because of this, Heckman chose to share his methods in the context of the reanalysis of the *High/Scope Perry Preschool Study* (Heckman et al., 2011). In this reanalysis using statistical procedures like permutation inference and imputation methods (simple piecewise linear interpolation, cross-sectional regression, kernel procedures, and estimated dynamic earnings functions), the small sample size of the *High/Scope* study was found not to be of concern. Results related to the null hypothesis of the no treatment effect were confirmed. In the end, Heckman et al. (2009) found that the study did indeed have internal validity and that again the results favored positive benefits for students enrolled in the pre-k program.

Head Start Impact Study. As stated in Chapter 1, the origins of Head Start date back to 1964 as part of a multifaceted effort by the government to wage war on poverty.

There is considerable longitudinal data about the effects of the Head Start program because it is the longest standing publicly funded pre-k program. Upon reauthorization of the Head Start program in 1998, Congress required the U.S. Department of Health and Human Services to evaluate the impact of Head Start on the children that it served by asking two significant sets of questions:

1. What difference does Head Start make to key outcomes of development and learning (and in particular, the multiple domains of school readiness) for low-income children? What difference does Head Start make to parental practices that contribute to children's school readiness?
2. Under what circumstances does Head Start achieve the greatest impact? What works for which children? What Head Start services are most related to impact? (History of Head Start, 2017).

To do this, the *Head Start Impact Study* (2010) was designed using criteria specifically required by mandates within the legislation and recommendations offered by the United States Department of Health and Human Services Advisory Committee on Head Start Research and Evaluation. The study included approximately 5,000 newly entering 3- and 4-year-old children in a nationally representative sample. Participants were randomly assigned to one of two groups; participants who would receive Head Start services and participants who would not. These students were followed throughout their pre-k, kindergarten, and first grade years. Age-specific cohorts were compared to examine the impacts of participants attending Head Start beginning at age three and those beginning at age four. Different from *The High/Scope Perry Preschool Study*,

students in the group not participating in the Head Start programs were permitted to attend other child care or non-Head Start programs.

Findings related to student's academic performance suggest that participation in Head Start had positive effects on school readiness (*Head Start Impact Study*, 2010). Positive findings for 3-year-old students were found in the areas of vocabulary, letter-word identification, pre-academic skills, letter naming, phonological processing, and parent-reported emergent literacy (*Head Start Impact Study*, 2010). Positive findings for 4-year-old students were found in the areas of vocabulary, letter-word identification, spelling, pre-academic skills, color identification, letter naming, and parent-reported emergent literacy (*Head Start Impact Study*, 2010). These findings are commensurate with other studies' findings supporting the short-term effects of pre-k programs on early literacy.

In contrast to the *High/Scope Perry Preschool Study*, the *Head Start Impact Study* (2010) found that advantages gained in school readiness throughout Head Start appeared to diminish by the end of first grade. Findings for 3-year-old students were similar in nature with minor variations in parent-child relationships (*Head Start Impact Study*, 2010). While these findings suggest that the benefits of pre-k participation disappear after a few years, longer-term findings suggest the contrary. Longitudinal data suggests that findings like the *Head Start Impact Study* (2010) fail to identify persistent beneficial effects, like high school graduation, higher education degree attainment, and a myriad of other financial factors related to higher lifetime earned income, for students identified as at-risk. It is also important to recognize that unlike some of the other studies discussed, the *Head Start Impact Study* control group permitted enrollment in

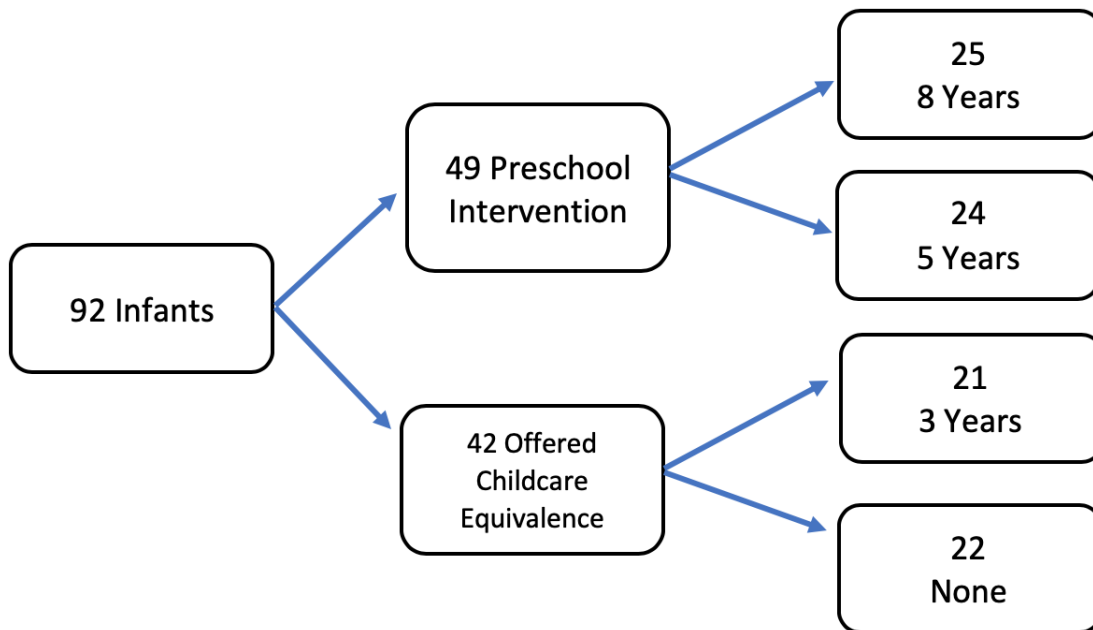
other preschool programs. This may hide some of the beneficial effects of the Head Start program on longer-term outcomes.

Abecedarian Project. *The Abecedarian Project* is another example of a pre-k program in which participants have been followed longitudinally. This comprehensive pre-k program, operated between 1972 and 1985 in North Carolina, serving infants (age six weeks to three months) through students age five. One hundred eleven infants identified as at-risk for developmental delays or school failure were randomly assigned to a treatment group where they received the intervention of pre-k instruction six to eight hours a day, five days a week, for 50 weeks a year. Instruction focused on the development of cognitive, language, and adaptive behavior through interactions and play. In addition to curriculum, students received wrap-around-services to include: nutritional supplements, pediatric care, and social work services. The selection of candidates for the study came from referrals from local hospitals, clinics, and the Department of Social Services. Referrals were screened through a home visit and then a follow up interview and psychological assessment. Results from the interviews and assessments were scored on a weighted rubric that identified children as being at-risk and thus eligible for inclusion in the pre-k program and consequently the study (Kilburn, Cannon, Mattox, & Shaw; 2014).

Unique to this project was the inclusion of a school-age transition intervention for the first three years of elementary school. Students receiving this intervention were assigned a resource teacher who acted as a liaison between the school and the home. Resource teachers assisted in creating supplemental activities to be completed in the home, worked with parents on understanding the school curriculum, better preparing

them to assist their children, met with classroom teachers to align home activities with curriculum being taught in school, provided direct tutoring to students, and helped facilitate summertime opportunities like camps, public library access, and additional tutoring (Kilburn, et al.; 2014).

The research design of *The Abecedarian Project* included the random assignment of 111 infants into two groups, those who received a pre-k intervention and those who did not. These participants were randomly assigned into two further groups, those who received an intervention during the first three years of elementary school and those who did not. Of the 111 infants identified for participation, 57 were assigned to the pre-k treatment group. The remaining 54 were offered childcare deemed equivalent to typical childcare for the time period. The second assignment resulted in: 25 participants receiving eight years of intervention (five years of pre-k and the first three years of elementary school), 24 participants receiving five years of intervention (five years of pre-k), 21 participants receiving three years of intervention (during the first three years of elementary school), and a control group of 22 who did not receive intervention of any kind. Due to attrition, 92 participants remained at the conclusion of the study (Ramsey & Campbell, 1984).

Figure 1. Abecedarian Project Research Design

As the nature of the project was to provide a comprehensive program for children at-risk of developmental delays and school failure, it is not surprising that all participants came from families with low-income. The demographic makeup of the study's participants is an area to note when considering the possible generalizability of the study: 100% low-income, 98% African-American, and 83% from single parent households headed by the mother. There was a fairly even gender split in the sample with 53% classified as female (Ramsey & Campbell, 1984).

Follow up data was collected and analyzed at ages 8, 12, 15, 21, 30, and 35. Participants who took part in the intervention groups had higher scores on the full-scale Wechsler intelligence tests, the verbal intelligence tests, and within various domains of the Woodcock-Johnson scales (Campbell et al., 2002). Furthermore, participants who received interventions had: completed more years of schooling, 12.2 versus 11.6; had a

far less likelihood of being retained in school, 32% of students who received the intervention had been retained compared to 57% of students within the control group (Campbell and Ramey, 1994); and were much less likely to be teenage parents, 26% compared to 45% (Campbell et al. 2002). It should be noted that unlike the *High/Scope Perry Preschool Study*, no significant differences were found related to conviction and incarceration rates, employment, or high school graduation rates (Campbell et al. 2002).

Much like the *High/Scope Study* discussed earlier, cost-benefit analyses of *The Abecedarian Project* have found beneficial financial returns to society. Masse and Barnett (2002) found a return to society of four dollars to every one dollar spent. Their analysis found that the program cost \$17,099 (2011 dollars adjusted for inflation) and returned approximately \$68,000 in savings related to future earnings and health benefits. Similarly, Schweinhart (2013) found a return to society of \$3.78 per dollar spent. Longitudinal analyses of quality pre-k programs like the *High/Scope Study* and *The Abecedarian Project* definitively reveal benefits for not only individual participants but for society as a whole. These studies demonstrate that participation in quality pre-k programs is beneficial to children coming from lower socio-economic environments and to society.

Virginia Preschool Initiative (VPI). The Virginia Preschool Initiative (VPI) was developed by the Virginia Department of Education to provide quality preschool for at-risk 4-year-old children across the Commonwealth of Virginia who were not served by Head Start (VDOE, 2015). VPI is a jointly funded pre-k program, between the state and localities, that works to expand access and improve the quality of pre-k opportunities for students who are: 1. from homes with a family income at or below 200% of the poverty

line; 2. homeless; 3. children of parents or guardians who are high school dropouts; and/or 4. students with special needs or disabilities coming from family homes with incomes less than 350 percent of federal poverty guidelines. A majority of the funding is derived from the state with an average of 25% of funding coming from matching local funding (VDOE, 2015).

VPI's creation stems from legislative action beginning with the 1993 *Acts of Assembly*, Chapter 994, Item 126. The first VPI classes were offered in 1996 with the allocation of \$9.3 million dollars during the 1995 session of the Virginia General Assembly. Funding over the years has increased steadily to \$68.3 million dollars in 2015 with the ambitious goal of providing pre-k opportunities for all eligible students, as outlined above, not receiving Head Start services across the Commonwealth of Virginia (VDOE, 2015). This has not happened as of 2020.

To allocate funding for the specific number of VPI slots, the Commonwealth of Virginia uses a formula that subtracts the number of children being served by Head Start from the estimated number of at-risk 4-year-olds, determined by free and reduced lunch eligibility percentages (VDOE, 2015). During the 2014-2015 school year, this formula equated to VPI funding for approximately 26,000 students in 121 of the 135 school divisions across the Commonwealth of Virginia (VDOE, 2015).

The cost to localities, or percentage of contribution, is dependent upon a locality's ability to pay as determined by funding formulas that use state composite income indexes. The VDOE uses three local indicators, true value of real property (50%), adjusted gross income (40%), and taxable retail sales (10%), to determine a locality's ability to fund schools at the Standards of Quality (SOQ) level (VDOE, 2020).

SOQs are mandated minimum standards related to instructional programming and educational support services put out by the VDOE as required by the state constitution. Local contributions within localities with high composite indexes may fund in excess of 80% of per pupil expenditures while localities with lower composite indexes may only contribute as much as 20% of the per pupil expenditure (House Document No. 44, 2007). Much of the local portion of the per pupil expenditure is dependent upon per pupil calculations related to cost of living formulas.

Per pupil costs can vary vastly across localities. As an extreme example, the per pupil cost of a VPI student in Wise County, a county with a 2007 composite index of 0.2036, is \$5,700, while the per pupil cost of a VPI student in Alexandria City, a locality with a 2007 composite index of 0.8, is \$9,800 (House Document No. 44, 2007). It is important to note that local funding contributions include in-kind or in-direct funding such as the use of facilities (classrooms, electricity, water, materials), transportation, and site-based administration.

Similar to Head Start, the VPI program is a comprehensive quality pre-k program. In this situation, quality is defined as a pre-k program that uses research-based curriculum, has requirements ensuring that teachers and support staff meet minimum standards, and uses the Standards of Quality, and includes an evaluation system that requires onsite visits. In addition, teachers are required to hold at least a bachelor's degree and instructional assistants must have a Child Development Associate (CDA) credential or equivalent. Supplemental requirements of the program include access to at least one meal a day and the inclusion of onsite quality assurance visits (JLARC, 2015).

Instruction within VPI programs is based on Virginia's pre-k standards of learning, *Foundation Blocks for Early Learning: Comprehensive Standards for Four-Year-Olds*, which outlines the skills and knowledge deemed essential for kindergarten readiness. PALS is used as the standard measure of performance within the program. Students are tested at the beginning, middle, and end of the year. Statewide PALS results from the 2006² Fall administration indicate that kindergarten students who participated in a VPI program outperformed students who did not participate in a VPI program with average PALS performances of 58.7% to 55.7% respectfully (JLARC, 2015). This is further highlighted by a comparison of the percentages of students in need of reading intervention between students previously attending a VPI pre-k program and those who did not. Students who attended a VPI program compared to those who did not were less likely to require reading intervention (JLARC, 2015).

VPI+. In 2015, Virginia was awarded a federal preschool development grant of \$17.5 million dollars to improve and further expand access to pre-k across the Commonwealth. This grant was used to enhance the already established VPI program, a pre-k program serving approximately 18,000 four-year-olds, and to expand pre-k opportunities to an additional 13,000 children (VDOE, 2016). Eleven of the 132 school systems within Virginia participated in the expansion: Brunswick County, Chesterfield County, Fairfax County, Giles County, Henrico County, Norfolk County, Petersburg City, Prince William County, Richmond City, Sussex County, and Winchester City. The goal of enhancing VPI classes was to transform already established and successful pre-k

² 2006 data was the data included in the Virginia Preschool Initiative (VPI) joint subcommittee presentation to the Joint Legislative Audit Review Commission (JLARC) June of 2015 in response to a 2007 resolution directing JLARC to study VPI (JLARC, 2015).

classes into national pre-k exemplars by adopting effective best practices and creating an infrastructure of supports (VDOE, 2016). Supports include the use of research-based curriculum (Creative Curriculum), increased professional development to include 60 hours of required professional development, 40 hours of direct coaching, and formative assessment practices to progress monitor and guide instruction (PALS and Gold).

Implementation of VPI+ pre-k program directly supports the VDOE's goal of nurturing young learners by expanding access to quality preschool opportunities. This expansion of pre-k to more than 13,000 students continued to include disproportionate numbers of nonwhite students coming from low socio-economic households. In 2016, student demographics within the program were: 70% black, 13% Hispanic, 10% white, and 7% identifying across various other categories (VDOE, 2016). These demographics are not surprising given that the mission of many of the pre-k programs similar to VPI+ was to assist in closing K-12 academic achievement gaps across racial and socio-economic divides.

Evaluations of the VPI+ pre-k program show that students enrolled make growth. VPI+ literacy results from the 2015-2016 school year demonstrated statistically significant student gains on the PALS in 6 areas: alphabet recognition, beginning sound awareness, name writing, print/word awareness, rhyme awareness, and nursery rhyme awareness (VDOE, 2016). Pretest/post test scores demonstrated growth in students meeting or exceeding developmental ranges in all 8 early literacy skills measured by PALS with the greatest gains being made in Print and Word Awareness and Nursery Rhyme Awareness (VDOE, 2016).

Comparison of Pre-K Program Requirements. Pre-k programs vary greatly in their requirements. Some, like Head Start, have specific and detailed standards that outline broad expectations and specific requirements: “A program must ensure all staff, consultants, and contractors engaged in the delivery of program services have sufficient knowledge, training and experience, and competencies to fulfill the roles and responsibilities of their positions and to ensure high-quality service delivery in accordance with the program performance standards. A program must provide ongoing training and professional development to support staff in fulfilling their roles and responsibilities (US Department of Health and Human Services, 2009, p. 54).” Others, like Title I Pre-K, do not have many specific requirements pertaining to the operations or performance of the pre-k program.

The Office of Elementary and Secondary Education at the Department of Education (DOE) publishes non-regulatory guidance as educational legislation, like the *Every Child Succeeds Act* (ESSA). At the time of this study, the most recent Title I Pre-K guidance document was published in October of 2016. These documents are formatted similar to a Frequently Asked Questions (FAQ) document and primarily pertain to the overarching philosophy of pre-k and the logistics related to the use of funding to support the operations of a pre-k program. While not specific in details related to requirements like teacher licensure and professional development, the 37-page guidance document does mention the Head Start program a total of 54 times, a strong indication of a preference for modeling Title I Pre-K programs after Head Start.

Both VPI and VPI+ have very specific and detailed requirements that exceed those of Head Start and Title I. This is to be expected as both programs were passed

through the House of Delegates as efforts to expand and enhance pre-k services across the Commonwealth of Virginia. Similar to Title I Pre-K programs, Head Start requirements serve as the foundation for both of these programs. These programs are designed to build upon the already successful Head Start program and to further increase the quantity and quality of pre-k services with the goal of decreasing achievement gaps between socio-economic disparities and ultimately across race and ethnicity.

Inclusion of additional requirements related to teacher licensure, increased wrap around services, lower per pupil-ratios (PTR), and increased professional development account for differences in the cost to establish and maintain the four programs being studied. Some of the major differences in program requirements resulting in varying funding costs can be seen in the *Comparison of Pre-K Program Requirements Table* below. Specific costs related to each of the requirements are included in the methodology section as part of an ingredients list allowing for an overall comparison of costs between programs.

Table 1

Comparison of Pre-K Program Requirements

	Head Start	Title I	VPI	VPI+
Length of Day	Minimum of 3.5 hours for 160 days	Not defined	Half day: 3-hours, Full day: 5.5-hours	No half day, Full day: 5.5-hours
Licensure of Teacher	Associate's or Bachelor's degree in child development or early childhood education	Recommended	Required if paid from public funds	Required
Salary	Encouraged to be offered based on training and experience. Cannot be below minimum wage	Not defined	Comparable to K-12 teachers if paid from public funds	Comparable to K-12 teachers
Child-to- Adult Ratio	10:1	Not defined	9:1	9:1 / 8:1 in the school System studied
Class Size	20 max *4- & 5-year-old students	Not defined	18 max	18 max / 16 max in the school system studied
Curriculum	Research based, standardized training, aligned with the Head Start Early Learning Outcomes Framework	Aligned with the Head Start Early Learning Outcomes Framework	Aligned to the Foundation Blocks for Early Learning	Creative Curriculum or other approved curriculum aligned to the Foundation Blocks for Early Learning
Professional Development - Annually	Individualized and ongoing as appropriate	Not defined	15 hours	30 hours; Individualized PD plan; 40 hours of direct coaching
Snacks and Meals	Required	Not defined	No requirement	Provided
Assessment Requirements	Required but not defined	No Requirement	PALs	PALs, Gold

Pre-Kindergarten Structural Interventions and Quality-Supports

Some of the most prominent factors influencing positive pre-k academic outcomes are the implementation of research-based curriculum and increased professional development opportunities like teacher coaching (Phillips, et al., 2017). The presence of these interventions and supports vary across programs with the most recent programs containing the highest inclusion of such supports. These variations contribute to differences in the academic performance and growth of students (Phillips, et al., 2017) as well as in the overall cost to implement and maintain. Therefore, research like this is necessary to examine the complexities of the differences found not only in student early literacy achievement but in the overall costs to implement and maintain the four publicly funded pre-kindergarten programs (Head Start, VPI, VPI+, and Title I) offered in Virginia.

The implementation and existence of the pre-k programs offered across the Commonwealth of Virginia came about over time in response to opportunities arising from various political landscapes and governmental funding opportunities. Differences between the pre-k programs are related to requirements and performance indicators stipulated as conditions for receiving funding. The most prominent of these stipulations are structural interventions and quality supports such as: implementation of research-based curriculum, professional development requirements, participation in direct teacher coaching, teacher degree attainment and licensure, and the inclusion of varying levels and types of wrap around services.

In general, as pre-k programs in Virginia have evolved over the years, the amount and level of structural interventions and quality supports have increased. In

many cases, these increases have been significant. Examples of these can be seen in a comparison of requirements between the Virginia Preschool Initiative (VPI) and Virginia Preschool Initiative Plus (VPI+) programs. VPI only requires a teacher to be licensed if paid with public funds whereas the VPI+ program requires all teachers to be appropriately licensed. Similarly, VPI requires teachers to participate in 15 hours of professional development a year; whereas, VPI+ requires 30 hours of professional development, an individualized professional development plan for each teacher, and up to 40 hours of coaching annually (VDOE, 2016). Various studies support the inclusion of structural interventions and quality supports (Klein and Knitzer, 2006; Neuman and Wright, 2010; Weiland and Yoshikawa, 2013), with the implementation of research-based curricula paired with coaching as the most predominant (Weiland and Yoshikawa, 2013).

Cost-Effectiveness Analysis

In educational research, cost-effectiveness analyses (CEAs) are used to compare the costs of specific programs using a common measure of educational results. Their purpose is to measure and compare the effectiveness of specific interventions in monetary terms assigned to derived units of a common or shared performance measure. An example of this, as used in this study, is the cost of PALS-PreK gains measured between the administration of the Fall and Spring PALS-Pre-K assessment across students participating in identified pre-k programs. CEAs are practical in their use at the local level because they measure costs related to specific performance outcomes.

Up to this point in the review of literature, economic methods of analyses in the studies reviewed have primarily focused on the use of cost-benefit analyses. This focus on studies that have used CBAs is related to the prevalence of their use in many of the landmark studies conducted on the relevance of pre-k programs to date. Studies like the *Head Start Impact Study* (2010) and the *High/Scope Perry Preschool Study* focus on the monetary returns related to participation in a program rather than deciphering the most cost-efficient program in practice. The use of a cost-effectiveness analysis provides agents within the Local Educational Agency (LEA) information to best make practical decisions about the effectiveness of pre-k programs compared to their overall costs.

Conclusion

In their 2017 consensus statement, *The Current State of Scientific Knowledge on Pre-Kindergarten Effects*, Phillips, et al. recognized the efforts that states have gone to in developing and providing quality pre-k programs, writing that states have “displayed considerable ingenuity in designing and implementing pre-k programs” (p. 2). This has certainly been the case within Virginia as demonstrated by the robust funding and implementation of the VPI and VPI+ pre-k programs discussed earlier.

The effects of these pre-k programs on kindergarten readiness are evident (*Head Start Impact Study*, 2010; JLARC, 2007; Schweinhart, 2004; VDOE, 2016). Longitudinal results on established pre-k programs have been mixed, yet recent analyses have been more favorable of positive benefits. Longitudinal student performance within enhanced programs like VPI+ will take time to determine as the program only began in the 2015-2016 school year. Furthermore, only four years’ worth of data will be available as grant

funding for VPI+ expired at the conclusion of the 2018-2019 school year. At the conclusion of the 2018-2019 school year the continuation of the VPI+ pre-k program was left to local school systems to continue or assimilate into other preexisting pre-k programs. The school system included in this study chose to bring their existing VPI+ programs under their VPI umbrella.

By focusing on the costs and early literacy performance within and between the pre-k programs offered across Virginia to identify the cost-effectiveness of pre-k programs in early literacy instruction, this study steps back from previous CBA studies that look at broad overarching benefits to society to provide an analysis of the cost of one component of school readiness, early literacy performance. Traditionally, economic methods such as cost-benefit analyses have been used to justify the funding of such programs over other competing educational initiatives and programs. CBAs can be influential and persuasive in advocating for a particular practice because they place a monetary value on the predicted future outcomes of related factors such as crime, health, and annual earnings.

Previous economic evaluations of pre-k programs have done the same, largely examining and highlighting pre-k programs predicted economic benefits as their major findings. This study builds upon these economic evaluations, primarily emphasizing cost-benefits to the society as a whole, to look at the cost differences associated with students' early literacy performance between established pre-k programs. Simply put, this study builds upon the philosophy of predicted benefits found in the results of previous CBAs to an endeavor of examining the most cost-efficient practices available

in achieving agreeable early literacy gains; initially at a district level, but ultimately to be used at a broader level.

Chapter 3: Methodology

Introduction

Daily, educational leaders are tasked with developing and maintaining a public education system that prepares our youth for the future. This highly complex system of education is funded by braided federal, state, and local tax revenues. To be good stewards of all publicly allocated funds, educational leaders must be knowledgeable of the various regulations pertaining to each funding source. Additionally, the vast diversity of needs and finite amount of educational funding requires educational leaders to make difficult decisions and to prioritize programs and practices that produce the highest results for the lowest cost. In their book, *Economic Evaluation in Education, Cost-Effectiveness and Benefit-Cost Analysis* (2018), Levin, McEwan, Belfield, Bowden, and Shand explain this process as a “decision-oriented perspective.” They describe decision-oriented perspective as leaders looking for options that provide the lowest cost for any given increase in a preferred outcome.

This cost-effectiveness analysis on the early literacy growth of four pre-k programs offered within a large central Virginia school system provides data to assist in determining the most efficient pre-k program(s) in obtaining the highest level of early literacy skills growth and the costs associated with acquiring measured growth. As educational leaders and legislators prioritize budgets and debate the expansion of pre-k services and funding, this study helps provide context to the effect, cost, and effectiveness of 3 current pre-k programs (Head Start, VPI, and Title I) offered in Virginia in addition to the cost, effect, and effectiveness of a pre-k program terminated at the conclusion of the 2018-2019 school year. Funding for the VPI+ pre-k program

expired at the conclusion of the 2018-2019 school year, leaving individual school systems to decide the fate of the VPI+ pre-k program by: absorbing the grant portion of costs, merging the program with one or more of the other pre-k programs offered, or terminating the program. Keeping this in mind, the research questions developed were designed to determine if there were differences in early literacy growth between the programs and, if differences existed, to determine the degree of difference; to determine the overall cost of each pre-k program; and to calculate the cost-effectiveness of each program in obtaining said early literacy growth.

Research Questions

1. Are there differences in students' PALS growth based upon the pre-k program attended?
2. What is the cost of delivering pre-k education by program?
3. What is the cost-effectiveness, as measured by early literacy growth, of pre-k programs offered within the school system being studied?

Methodological Approach

This study used a cost-effectiveness analysis (CEA) to investigate and compare the costs associated with the early literacy skills growth of students within four distinct pre-k programs. As CEA are used to compare programs based on their costs to educational results (Boardman, Greenberg, Vining, and Weimer, 2011; Levin, McEwan, Belfield, Bowden, and Shand, 2018), this design was appropriate to address the research questions posed. The Phonological Awareness Literacy Screening (PALS) was used as the indicator of effect, measuring students' early literacy growth within each program. Findings provide members within the Local Educational Agency (LEA)

and the Virginia Department of Education (VDOE) information to best make decisions about the effectiveness of particular pre-k programs compared to their overall costs.

Setting

The setting selected for this study was a large public-school division located in central Virginia. The division serves approximately 60,000 students grades prek-12 and includes nearly 40 elementary schools, many of which offer one or more of the four different pre-k programs. Enrollment and participation within these pre-k programs were voluntary. Each program maintained acceptance criteria that are largely based upon individual risk factors such as adjusted household incomes and the presence of disabilities. Other criteria, such as age and residency, are included in participation eligibility. All participants included in this study were 4-years-old by September 30, 2017, and lived within the school attendance zone hosting the pre-k program.

There were 582 pre-k spaces available within 35 classes across the four pre-k programs offered. During the 2017-2018 school year, the available spaces for students within each program were more heavily concentrated within the Head Start and VPI+ programs; however, there are sufficient participants within the Title I and VPI pre-k programs for comparison within the CEA. Overall participant totals can be seen in the table below. Only students completing the pretest (Fall) and post (Spring) PALs assessment were included in the analysis.

Table 2

Participants by Pre-K Program for the 2017-2018 School Year

Pre-K Program	PTR Used	# of Student Spaces	# of Students Completing Pre/Post PALS	# of Classes
Head Start	9:1	198	179	11
Title I	9:1	112	107	7
VPI	9:1	112	105	7
VPI+	8:1	160	151	10
Total		582	542	35

In order to most accurately measure the effectiveness of the four individual programs, 2017-2018 school year financial, student enrollment, and early literacy growth data, as measured by the PreK PALS, was used in the cost-effectiveness analysis. 2017-2018 data was used as it best represents the distinct differences between the programs. VPI+ was first implemented during the 2016-2017 school year. Because the 2016-2017 data reflects the year in which the program was initiated and its practices established, this data was not a realistic reflection of the VPI+ program.

Third year, 2018-2019, data had limitations as well, as it reflected the outcomes of all programs that have been blended into a more “singular looking program.” During the 2018-2019 school year there was a concerted effort within the school system studied to create more equitable pre-k programs through the use of a common research-based curriculum and by consolidating professional development opportunities. The State Superintendent, Dr. James Lane, indicated a desire to do the same at the state level; this blending of practices reduces distinctions between the programs, making a comparison of program outcomes and costs difficult. Therefore, it

was logical to infer that the 2017-2018 school year data would show the most distinctions between the pre-k programs in their intended construct, making the 2017-2018 school year data the most appropriate for this cost-effectiveness study.

As a brief review from chapter one, there are four distinct pre-k programs funded across the Commonwealth of Virginia and the school system studied: Head Start, Title I, the Virginia PreSchool Initiative (VPI), and the Virginia PreSchool Initiative Plus (VPI+). These programs varied in funding, structure, and curriculum. Head Start is federally funded and is the oldest of the programs. It was established as a means to assist in “The War on Poverty” and is a comprehensive program including more holistic components such as medical, social, and general education services (History of Head Start, 2017; U.S Department of Health, Education, and Welfare, 1972).

Title I Pre-K classes are funded by the LEA’s use of Title I appropriations and are the least regulated of the four pre-k programs studied. Up to this point, little guidance has been given related to the use of Title I funding in the establishment and maintenance of pre-k classes. The regulatory guidance offered merely defines the purpose of Title I Pre-K as a “program for which a Local Education Agency (LEA) or school uses Title I funds, in whole or in part, to improve cognitive, health, and social-emotional outcomes for eligible children below the grade at which an LEA provides a free public elementary education” (USDOE, 2012, p. 3). Particular requirements related to professional development, coaching, curriculum, etc., are not established as with the other pre-k programs.

The Virginia Preschool Initiative was established in 1996 and is primarily a state funded program for at-risk 4-year-old children not served by Head Start (VDOE, 2017).

The fourth and final pre-k program, the Virginia Preschool Initiative Plus program was the most recent iteration of pre-k programs and was derived from the Head Start and VPI initiatives. Funding for VPI+ ended at the conclusion of the 2018-2019 school year. This program was funded through the United States Department of Education's Preschool Development Grant (PDG), as an expansion of VPI, meant to increase access to high quality pre-k opportunities (VDOE, 2017). VPI+ increased the capacity of enrollment for 4-year-old students by more than 13,000 across the state over a four-year period. Students qualifying for participation were those not served by other publicly funded programs like Head Start and VPI yet, still deemed at-risk primarily determined by annual income (VDOE, 2016).

The school district chosen as the site for this study was chosen for several reasons: 1. racial and gender demographics of the state population and that of the district population are close in proximity (see Tables 4 through 5 and Figures 2 through 4); 2. this school system hosted all four publicly funded pre-k programs offered across the Commonwealth of Virginia (Head Start, Title I, VPI, and VPI+) during the 2017-2018 school year; 3. the large participant size (542 pre-k students); and 4. the availability and convenience of access to the data. Although similar to state data in many aspects, the 2017-2018 school year socio-economic demographics of the division (75% of students enrolled in the pre-k programs qualify for Free and Reduced Lunch) do not match that of the state (48% of students enrolled in the pre-k programs qualify for Free and Reduced Lunch) (VDOE, 2019). This is of particular interest, as all four pre-k programs studied were designed with the purpose of reducing the achievement gap of students identified

as *at-risk* and three of the four programs (Head Start, VPI, VPI+) use adjusted household income as part of their acceptance criteria.

The Title I Pre-K program did not use adjusted household income as an acceptance criterion; however, the program had to be hosted in a Title I school. Schools receiving Title I funding have a high number of students qualifying for free and reduced lunch (FRL), which is determined using adjusted household incomes. The US Department of Health and Human Services publishes yearly Federal Poverty Level (FPL) guidelines, also known as “poverty guidelines” annually. The FPL is used to determine eligibility for government benefits such as Medicaid, food stamps, free and reduce lunch, etc. See Table 3 below for the 2017 published guidelines.

Table 3

2017 FPL Guidelines for the 48 Continental States and D. C.

Persons in Household	Federal Poverty Level
1	\$12,060
2	\$16,240
3	\$20,420
4	\$24,600
5	\$28,780
6	\$32,960
7	\$37,140
8	\$41,320

Add \$4,180 for each additional person above 8.
(ASPE, 2017)

Even though the state and local racial and gender demographics closely aligned, the overall makeup of the pre-k student population within the school division varied

greatly. There were significantly more students reporting as black and Hispanic (39.11% and 36.53% respectively) enrolled within the pre-k programs studied. Conversely, there were significantly fewer students reporting as white enrolled within the pre-k programs studied (17.53%, within the pre-k programs studied, compared to 48.95% and 50.18% at the state and school division levels respectively). Tables 4 and 5 and Figures 2 through 4 detail these demographic similarities and differences across race, ethnicity, and gender at the state, division, and pre-k levels than across the state.

The demographic category within this study mirrored the VDOE membership reporting characteristics, as this was the data available. These characteristics entwine ethnicity and race into one reporting category. Reporting characteristics within the category include: American Indian or Alaska Native; Asian; Black, not of Hispanic origin; Hispanic; Native Hawaiian or Pacific Islander; Non-Hispanic, two or more races; Unknown; and White, not of Hispanic origin. Within the PALS-PreK dataset, Hispanic is separate from the racial reporting category. Therefore, to standardize the demographic information, students reporting as Hispanic in the PALS-PreK dataset were removed from their other reporting indicator. For instance, if a student was identified as Hispanic and white within the PALS-PreK dataset, they were coded as Hispanic and removed from the white reporting category count. This allowed the VDOE and PALS-Pre-K demographic information to be compared. As the VDOE demographic information did not further differentiate the Hispanic reporting characteristic into white Hispanic and black Hispanic, it was not possible to convert the VDOE data into two corresponding reporting categories of ethnicity and race similar to the PALS-PreK dataset. One other

consideration of this category relates to the assignment method of students into characteristic groups. Student assignment is solely dependent upon parental-reporting.

Table 4

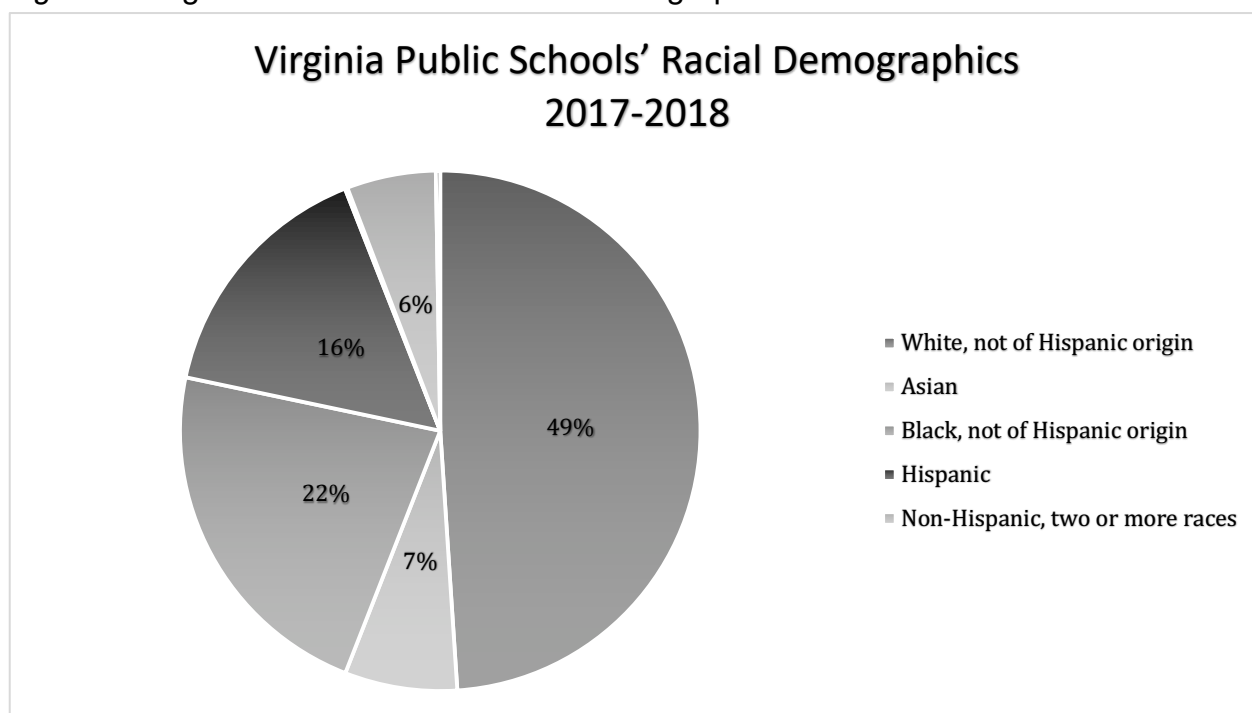
Racial Demographic Comparisons for the 2017-2018 School Year

	Virginia Public Schools	%	School Division	%	Division Pre-K Classes	%
White, not Hispanic	632,811	48.95	30,597	50.18	95	17.53
Asian	90,371	6.99	2,066	3.39	9	1.66
Black, not Hispanic	289,012	22.36	15,692	25.73	212	39.11
Hispanic	203,364	15.73	9,542	15.65	198	36.53
Native Hawaiian or Pacific Islander	2,047	0.16	107	0.18	3	0.55
Non-Hispanic, two or more races	71,613	5.54	2,855	4.68	24	4.43
American Indian or Alaska Native	3,488	0.27	117	0.19	1	0.18
Total	1,292,706		60,976		542	

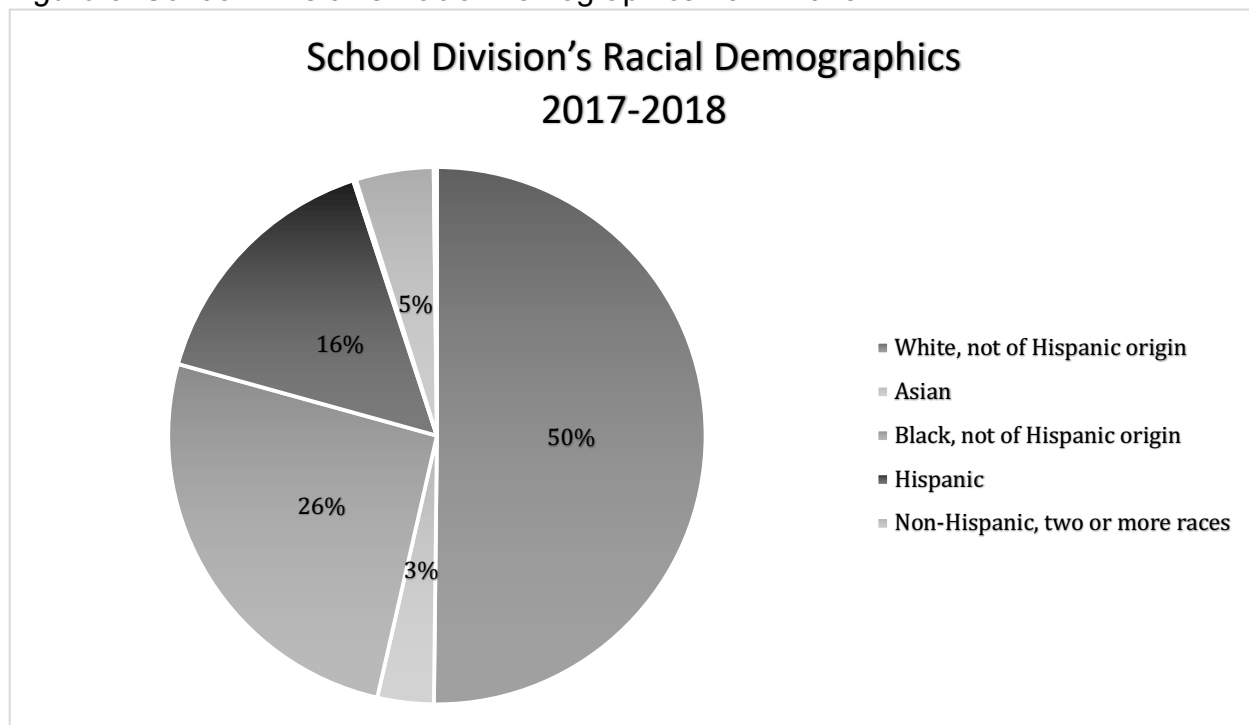
Table 5

Gender Demographic Comparisons for the 2017-2018 School Year

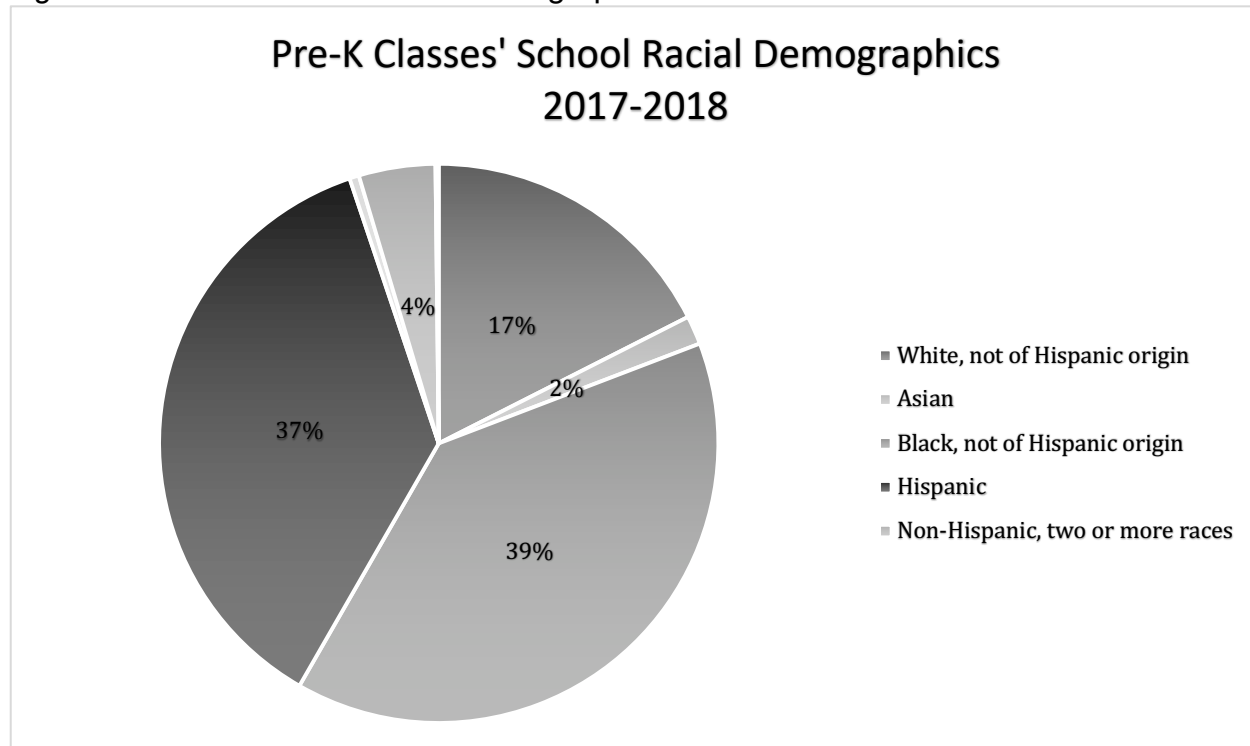
	Virginia Public Schools	%	School Division	%	Division Pre-K Classes	%
Female	627,219	48.52	29,613	48.57	274	50.55
Male	665,487	51.48	31,363	51.43	268	49.45
Total	1,292,706		60,976		542	

Figure 2. Virginia Public Schools' Racial Demographics 2017-2018

VDOE, 2019

Figure 3. School Division's Racial Demographics 2017-2018

VDOE, 2019

Figure 4. Pre-K Classes' Racial Demographics 2017-2018

Outcome Measures

The Phonological Awareness Literacy Screening PreK (PALS-PreK) was used as the indicator of effect, measuring students' 2017 Fall to 2018 Spring early literacy growth within each program. PALS is a comprehensive assessment of early literacy skills that are predictive of future reading success. It is designed to identify students in need of reading intervention beyond that of typically developing students and to provide teachers with explicit data related to the foundations of reading (name writing, alphabet knowledge, beginning sound awareness, print and word awareness, rhyme awareness, and nursery rhyme awareness). PALS was developed by the University of Virginia and is the state-provided screening tool for Virginia's Early Intervention Reading Initiative (EIRI) (PALS, 2019). The EIRI is a state initiative to provide reading intervention and

support to kindergarten through third grade students identified through the administration of a diagnostic reading assessment, PALS. Its intent is to reduce the number of students with reading challenges through early diagnosis and data driven intervention (PALS, 2019).

PALS-PreK is an extension of other PALS tools. It is important to note that the PALS-PreK is meant to be used as formative data with the intent of informing instructional planning. Because of this distinction of purpose, the PALS-PreK does not calculate a summed score. For this study, a summed score and a summed developmental range, listed in Table 6, were created and used as measures of growth. Subtest developmental ranges are established within the PALS-PreK tool, not created for this study. For this study, the overall developmental ranges of below (0-52), on (53-87), and above (88-125) were created in a manner consistent with the PALS-K and PALS 1-3 tools, which define overall developmental ranges by adding all subtests' lower and upper limits together.

Table 6

PreK PALS Developmental Ranges

Subtests	Fall	Mid-Year	Spring	Total Possible Points
Name Writing	N/A	N/A	5 – 7	7
Uppercase Alphabet Recognition	N/A	N/A	12 – 21	26
Lowercase Alphabet Recognition	N/A	N/A	9 – 17	26
Letter Sounds	N/A	N/A	4 – 8	26
Beginning Sound Awareness	N/A	N/A	5 – 8	10
Print & Word Awareness	N/A	N/A	7 – 9	10
Rhyme Awareness	N/A	N/A	5 – 7	10
Nursery Rhyme Awareness	N/A	N/A	6 – 10	10
Totals	N/A	N/A	53 - 87	125

(PALS, 2019)

The use of PALS-PreK as the measure of literacy growth was chosen for several reasons:

1. Through the EIRI, the state provided the PALS free of cost to all public-school divisions, including the one used in this study.
2. The school division being studied administered the PALS-PreK to all pre-k students three times a year; Fall, Winter, and Spring. Assessments were completed by the teacher or other professionals one-on-one with individual students.
3. The data was readily available.
4. The assessment has acceptable internal consistency, as determined by the examination of the results of more than 700 students across four pilot studies.

Guttman's split-half reliability coefficient estimates range from .71 to .94 across the six subtests administered. Cronbach alpha coefficients range from .75 to .93 across the same subtests (Invernizzi, Sullivan, Meier, & Swank, 2004).

5. The assessment has inter-rater reliability as determined by .99 Pearson correlation coefficients in five of the six sub tasks (Invernizzi et al., 2004).
6. The assessment has acceptable content validity, construct validity, and criterion-related validity (Invernizzi et al., 2004).

This CEA compares the overall cost of each program per student to their early literacy gains on the PALS-PreK to determine a cost-effectiveness ratio (C/E). Tables 7 and 8 below explain how the results are displayed in Chapter 4. The first column lists the interventions studied, in this case individual pre-k programs. The second column is derived from an extensive review of the overall cost of each pre-k program. Overall costs are derived using the ingredients method. Column three displays the results early literacy mean gain scores on the PALS-PreK. In a second analysis of results, growth between developmental levels was used to assist in further understanding differences between the programs. The final column is used to list C/E ratios; allowing for the comparison of the effectiveness of each program monetarily. In this case, the C/Es represents the cost per one-point increase in gain scores on the PALS-PreK assessment and in the secondary analysis the cost associated with increasing between developmental ranges. This analysis uses a comparison of means. Results are specific to the overall performance and cost of the interventions and growth, not the individual performance of any one specific pre-k class or student.

Table 7

Cost-Effectiveness Analysis of Four Pre-K Programs – Mean Gains

Pre-K Program/ Intervention	C Cost per Student per Year	E Effect on Early Literacy Mean Gains (PALS Pre/Post)	C/E Cost-Effectiveness Ratio
Head Start	\$...	/
Title I Pre-K	\$...	/
VPI	\$...	/
VPI+	\$...	/

Table 8

Cost-Effectiveness Analysis of Four Pre-K Programs – Developmental Range Gains

Pre-K Program/ Intervention	C Cost per Student per Year	E Effect on Developmental Range Gains (PALS Pre/Post)	C/E Cost-Effectiveness Ratio
Head Start	\$...	/
Title I Pre-K	\$...	/
VPI	\$...	/
VPI+	\$...	/

Costs

To determine the cost of each pre-k program, an ingredients method was employed using a cost worksheet organized using the Virginia Department of Education's (VDOE) Online Management of Education Grant Awards (OMEGA) classifications. OMEGA is the VDOE's automated grant reimbursement and application system used to process grant expenditure reimbursements, budget transfers, and

application requests (VDOE, 2012). The ingredients method is a simple transparent way to understand and compare the overall or culminating cost of programs by breaking down costs of a particular program into contributing factors much like the breakdown of ingredients in a recipe.

OMEGA categories used as the ingredients to determine overall program cost allowed for expenditures to be clustered into homogeneous categories. This helped highlight distinctions between the programs and illuminate the costs and potential reasons for observed variances. This practice allowed for programs to be compared on a more fine-grained level. Each of the categories is clearly defined below:

- Personal Services (1000) includes salaries and wages. This includes sick leave, vacation, holidays, jury duty, military leave, and all other paid absences. This category also includes compensation paid through salary reduction plans, such as tax-sheltered annuities and flexible benefit plans (VDOE, 2017).
- Employee Benefits (2000) accounts for all job-related benefits. This includes fringe benefits such as the employer's portion of FICA, pensions, insurance (life, health, disability income, etc.) and employee allowances (VDOE, 2017).
- Purchased/Contracted Services (3000) includes services from outside sources such as private vendors and other government entities. Food purchases such as prepared meals, working meals, and/or catered services purchased through a vendor are included in this object code. Also included in this category is transportation payments to public carriers for the transportation of pupils on vehicles that are used by the public such as transit buses, taxicabs, airplanes, and intercity/interstate passenger buses (VDOE, 2017).

- Internal Services Charges (4000) includes costs for the use of intergovernmental services, such as data processing, automotive/motor pool, central purchasing/central stores, print shop, and risk management. These services are provided by internal services within the School District (VDOE, 2017).
- Other Charges (5000) includes expenditures that support the use of programs including utilities, staff/administrative/consultant travel, office phone charges, training, leases/rental, and indirect costs (VDOE, 2017).
- Materials and Supplies (6000) includes materials that are consumable such as food purchases for snacks, vehicle supplies (fuel, oil, etc.), textbooks, instructional materials, software, and technology.
- An additional category, local matching, in-direct costs, or in-kind costs, was added to encompass costs incurred by the school division but not necessarily captured within grant reporting. Some of these costs are required by the grants, others are costs that include the use of school buses, Human Resources, school building administrators, etc.

Financial data was collected from various departments within the school system to include: the grants department, the budget department, benefits and compensation, Title I, VPI, and Head Start.

Data Analyses

An analysis of 542 students' early literacy performance on the PALS-PreK within four different pre-k programs (Head Start, Title I, VPI, VPI+) across 35 classrooms was compared to the overall cost of each individual pre-k program. All data, PALS-PreK (Fall and Spring) scores, as well as detailed financial costs were collected as part of a formal

request to the school division studied. The school system studied required the completion of a review by the University's Institutional Review Board (IRB) prior to releasing the data.

This study asked three research questions to assist in understanding the performance and costs of the four pre-k programs offered. Each of these questions (1. Are there differences in students' PALS growth based upon the pre-k program attended? 2. What is the cost of delivering pre-k education by program? 3. What is the cost-effectiveness, as measured by early literacy growth, of pre-k programs offered within the school system being studied?) assisted in gathering information to more fully understand the complexities of the cost, performance, and efficiency of each of the pre-k programs reviewed. To determine if there were differences in students' PALS-PreK gain scores based upon the pre-k program attended, two analyses were conducted; a one-way ANOVA comparing Fall and Spring PALS-PreK gain scores between the four pre-k programs and a one-way ANOVA comparing Fall and Spring PALS-PreK developmental movement between the ranges of below, on, and above. The cost of delivering pre-k education by program was determined using the ingredients method described above in the cost section. The cost-effectiveness of pre-k programs being studied was calculated as a ratio of cost per student to growth on the PALS-PreK mean gain and to developmental range movement.

Data Security and Confidentiality

Data provided by the school system protected student identities by removing identifiable information like student names and identification numbers. For comparison purposes, comparing Fall and Spring PALS-PreK scores, students were assigned

numbers by the school division. Additionally, all student data was kept on a secure server hosted by the Virginia Commonwealth University throughout the duration of the study. At the completion of the dissertation defense, electronic data will be deleted. All other data used, such as financial data, pre-k program data, etc., was subject to the Freedom of Information Act (FIOA) and is considered public.

Timeline

The timeline for this study began upon successful completion of a prospectus defense and the receipt of an IRB exemption. A request to the school system studied was put in concurrently as the request for IRB exemption. Once the IRB exemption was granted, the school division released the requested PALS-PreK dataset and granted access to personnel to determine the financial costs of the four pre-k programs studied. The IRB and school division approval process took approximately 10 weeks.

Collection of financial data through review of grants and financial documents, in addition to various interviews, meetings, and correspondences took 10 weeks. PALS-PreK data was received within a week of IRB approval. Upon receiving the requested data from the school system, data was prepared for analysis. Data needed to be cleaned, merged, and coded. Data preparation and analysis took approximately 10 weeks and was conducted concurrently with the collection of financial data. The final two weeks of the study included the CEA.

Summary

In summary, the steps in the methodology for conducting this study included: 1. calculating two early literacy growth scores by comparing the mean gains of the pretest/posttest PALS-PreK scores and by comparing movement between

developmental ranges of students within the four programs; 2. determining the cost of each pre-k program using the ingredients method; and 3. calculating C/E ratios.

Findings from this study provide a broad overview of students' early literacy growth and the costs associated with achieving said early literacy growth by pre-k program attended. This study does not account for individual practices that may be the cause or combination of causes for higher growth rates at lower costs or for growth benefits to other kindergarten readiness indicators such as number sense and social emotional readiness. As this study was intended to evaluate the overall performance of each program related to their cost, not the specific practices contributing to the performance of each program, these limitations should not distract from the overall findings or the purpose of the study; which was to: 1. determine if there are differences in students' early literacy growth based upon the pre-k program attended; 2. measure the cost of delivering pre-k education by program; and 3. to calculate the cost-effectiveness of the four pre-k programs offered.

Chapter 4: Results

Introduction

In searching for the most cost-effective pre-k program that obtains acceptable early literacy growth within the school system studied, an early literacy growth score was constructed for each of the four pre-k programs. This was done by creating Fall (pretest) and Spring (posttest) summed scores. Fall summed scores were then subtracted from Spring summed scores creating an early literacy growth score, which allowed for comparison of the pre-k programs' performance and later their effectiveness. Overall costs of each pre-k program were used to create a cost-effectiveness ratio (C/E) which allowed for an overall analysis of the performance and cost of each pre-k program.

Due to some concerns related to the compression of mean gain scores, an additional analysis of the PALS-PreK data was conducted to examine movement between developmental ranges within each pre-k program. The results of this study are presented in three parts: 1. an explanation of the PALS-PreK analyses of early literacy performance; 2. an account of the overall costs of each of the four pre-k programs offered (Head Start, Title I Pre-K, VPI, and VPI+); and 3. a cost-effectiveness analysis (CEA) of early literacy growth compared to the overall cost per student. CEA results are presented in mean gain score growth and in developmental range attainment.

PALS Growth

As discussed earlier, the PALS-PreK was not designed to be a measure of early literacy growth (PALS, 2019); however, PALS-PreK data was used for various reasons:

1. At the time of this study, the PALS-PreK data was the only common measure of early

literacy performance across the four pre-k programs studied; 2. The PALS-PreK has established developmental ranges that are predictive of future reading success (PALS, 2019); 3. The tool has acceptable reliability and validity (Invernizzi et al., 2004); 4. The assessment is administered in the Fall, Winter, and Spring, allowing for a pretest/posttest analysis of different interventions; and 5. PALS-PreK data has been used in previous implementation and performance evaluations of pre-k programs like VPI and VPI+ (JLARC, 2015).

Due to issues related to students scoring the maximum amount of points possible within some subtests on the pretest, growth scores experienced compression. This compression is a phenomenon that may have reduced the mean gain scores of students within particular pre-k programs and may account for some of the lack of variance between programs' early literacy performance results. To compensate and conduct a more comprehensive analysis, a supplementary analysis looking at movement between developmental ranges was conducted. An additional analysis to address compression was also completed, which removed students scoring in the highest developmental range (88 – 125) from the final analysis. This removal of 29 students helped decompress scores in the mean gain analysis from an overall mean of 64.21 to 66.58. Ultimately, two analyses of the PALS-PreK data were included in this study, an analysis of the early literacy mean gain scores across the four pre-k programs and an analysis of the movement of students between the developmental ranges established within the PALS-PreK.

To conduct the analysis of the early literacy mean gain scores, Fall and Spring summed scores were constructed for each pre-k program by adding the eight subtest

scores included within the tool (name writing, alphabet uppercase identification, alphabet lowercase identification, letter sounds, beginning sound awareness, print word awareness, rhyme awareness, and nurse rhyme awareness) together and subtracting the Spring summed scores from the Fall summed scores. As stated earlier, the PALS-PreK tool does not calculate a summed score because its intended use is to guide instruction not to measure growth. The creation of the summed scores followed the method used in the PALS K and PALS 1-3 tools which do calculate summed scores. Table 9 gives a visual representation of the subtest scores used to calculate the Fall and Spring summed scores. Scores included in Table 9 are maximum scores available.

Table 9

PALS-PreK Subtest Scores used to Calculate Summed Scores

Name Writing	Alphabet Uppercase ID	Alphabet Lowercase ID	Letter Sounds	Beg. Sound Aware	Print Word Aware	Rhyme Aware	Nurse Rhyme Aware	Sum Score
7	26	26	26	10	10	10	10	125

Two one-way analyses of variances (ANOVAs) were conducted to test the research question asking if the pre-k program attended had an effect on students' early literacy performance as measured using the PALS-Pre-K, one with mean gain scores and one using movement between developmental levels. Even though this study looked at an entire population, rendering the need to meet inferential statistical assumptions unnecessary, six assumptions were evaluated prior to conducting each ANOVA. This was done to assess the generalizability of the results to a larger population.

1. The dependent variable of early literacy growth is continuous. The PALS-PreK growth score was created on a 0 – 125 scale. Additionally, the developmental

ranges that were used measured growth on a scale of 1, 2, and 3, using ranges within the 125 total points available.

2. The independent variable of pre-k programs attended consists of four independent groups: students within Head Start, Title I Pre-K, VPI, and VPI+ programs in the school system studied.
3. Independence of observation: Students could only be enrolled in one of four pre-k programs offered.
4. No significant outliers: Only one outlier needed to be removed from the dataset. This score was considered an outlier because it was the only data point to act contrary to all other data points. It was the only score to regress between the Fall and Spring administration of the PALS-PreK. Additionally, it fell outside of the interquartile range (IQR) using the formula $IQR = Q_3 - Q_1$.
5. Normal distribution of the dependent variable: This assumption was met by the size of the population. 514 students, after 29 students were removed for entering pre-k within the developmental range of “above” (88-125), were included in the analysis.
6. Homogeneity of variance: Levene’s test on the mean gain analysis showed that the variances between programs’ early literacy gain scores were not equal, $F(3 - 510) = 7.67$, $p = 0.000$. Levene’s test on the movement between developmental ranges showed that the variances between programs in attainment of increases of placement within early literacy developmental ranges were equal, $F(3 - 510) = 2.084$, $p = 0.101$.

All the inferential statistical assumptions were met for both ANOVAs, except the homogeneity of variance for the mean gain score analysis. Just as it was unnecessary to meet the inferential statistical assumptions, the concept of significance or hypothesis testing is not relevant when working with an entire population. Hypothesis testing assumes the use of a randomly selected and randomly assigned sample.

Descriptive statistics for PALS-PreK performance (Fall, Spring, and gain scores) are included in Tables 10 through 15 below to give an overall understanding of student performance entering and exiting pre-k by program. When looking at students entering pre-k by program, Head Start had the lowest PALS-PreK mean score at 24.43 with VPI+ having the highest at 31.53. Exiting scores had Title I Pre-K with the highest mean score at 99.38 and Head Start with the lowest overall mean score at 90.70. Gain scores were in line with entering and exiting scores showing Title I Pre-K with the highest at 69.36, followed by VPI+ at 66.3, Head Start at 66.26, and VPI at 64.76. Considering that there was only a 4.60-point difference in mean gain scores, it can be inferred that the early literacy performance between pre-k programs does not differ greatly. When considering generalizability to similar groups, mean gain scores should be viewed with caution as the analyses failed to find statistical significance.

Table 10

Student Early Literacy Fall PALS-PreK Means with Above Developmental Range

Pre-K Program	Mean Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	32.11	24.98	115 (0 – 115)	1.07	542
Head Start	26.07	21.65	106 (0 – 106)	1.61	179
Title I Pre-K	37.61	27.31	107 (6 – 113)	2.64	107
VPI	34.26	26.09	113 (2 – 115)	2.55	105
VPI+	34.26	24.96	114 (0 – 114)	2.03	151

Table 11

Student Early Literacy Fall PALS-PreK Means without Above Developmental Range

Pre-K Program	Mean Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	28.34	19.74	87 (0 – 87)	0.87	513
Head Start	24.43	18.92	87 (0 – 87)	1.43	175
Title I Pre-K	30.02	17.82	79 (6 – 85)	1.83	95
VPI	28.95	19.59	85 (2 – 87)	1.98	98
VPI+	31.53	21.36	85 (0 – 85)	1.77	145

Table 12

Student Early Literacy Spring PALS-PreK Means with Above Developmental Range

Pre-K Program	Mean Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	96.32	25.98	116 (9 – 125)	1.12	542
Head Start	91.33	27.95	111 (14 – 125)	2.09	179
Title I Pre-K	101.7	22.43	110 (14 – 124)	2.17	107
VPI	95.69	30.85	116 (9 – 125)	3.01	105
VPI+	98.85	20.86	88 (37 – 125)	1.70	151

Table 13

Student Early Literacy Spring PALS-PreK Means without Above Developmental Range

Pre-K Program	Mean Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	94.91	25.99	116 (9 – 125)	1.15	513
Head Start	90.70	27.95	111 (14 – 125)	2.11	175
Title I Pre-K	99.38	22.72	109 (14 – 123)	2.33	95
VPI	93.70	30.99	116 (9 – 125)	3.13	98
VPI+	97.90	20.73	88 (37 – 125)	1.72	145

Table 14

Student Early Literacy Mean Gain Scores with Above Developmental Range

Pre-K Program	Mean Gain Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	64.21	25.29	114 (3 – 117)	1.09	542
Head Start	65.26	26.08	111 (3 – 114)	1.95	179
Title I Pre-K	64.09	26.42	110 (7 – 117)	2.55	107
VPI	61.99	28.94	108 (4 – 112)	2.82	105
VPI+	64.59	20.50	90 (11 – 101)	1.67	151

Table 15

Student Early Literacy Performance – Mean Gain Scores without Above

Pre-K Program	Mean Gain Score	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	66.58	23.81	114 (3 – 117)	1.05	513
Head Start	66.26	25.48	111 (3 – 114)	1.93	175
Title I Pre-K	69.36	23.01	109 (8 – 117)	2.36	95
VPI	64.76	27.89	108 (4 – 112)	2.82	98
VPI+	66.37	18.83	83 (18 – 101)	1.56	145

Due to the limited variance found between the early literacy gain mean scores of pre-k programs, a more detailed analysis was necessary to attempt to understand if there were more complex differences between the four pre-k programs. Since the purpose of pre-k programs is to ensure that students enter kindergarten developmentally ready, it seemed obvious to look at student performance through the attainment of developmental levels. The developmental ranges of *below*, *on*, and *above* used in the ANOVA, parallel the PALS-PreK Spring developmental ranges. Developmental ranges of the Spring PALS-PreK are listed in Table 6 in Chapter 3.

To conduct the analysis, Fall and Spring students' summed PALS-PreK scores, created in the previous analysis, were coded as a one (0-52) for below developmental range, two (53-87) for on developmental range, or three (88-125) for above developmental range. A developmental gain score was then created to measure developmental range attainment. Developmental range codes were then assigned to look at movement from *below to below*, *below to on*, *below to above*, *on to on*, and *on to above*. The category of *on to below* was not needed as no participants fell within this category. Additionally, all categories where the summed score began in the above range were excluded as in the previous analysis on mean gain scores.

Students' developmental level upon entering the four pre-k programs studied varied. Students enrolled in the Head Start pre-k program had the largest percentage of students within the *below* range at 88.3% and the least amount of students entering within the *above* range at 2.2%. The VPI+ program had the least amount of students entering in the *below* range at 76.8% and the most entering on level at 19.2%. The Title I Pre-K program had the most students entering within the *above* range at 11.2%.

Figure 5 and Table 16 more fully detail students' entrance placement on the developmental continuum. Fall and Spring Figures (5 and 6) and Tables (17 and 18) are placed side by side below for comparison purposes.

Figure 5. Student Early Literacy Performance by Developmental Ranges - Fall PALS

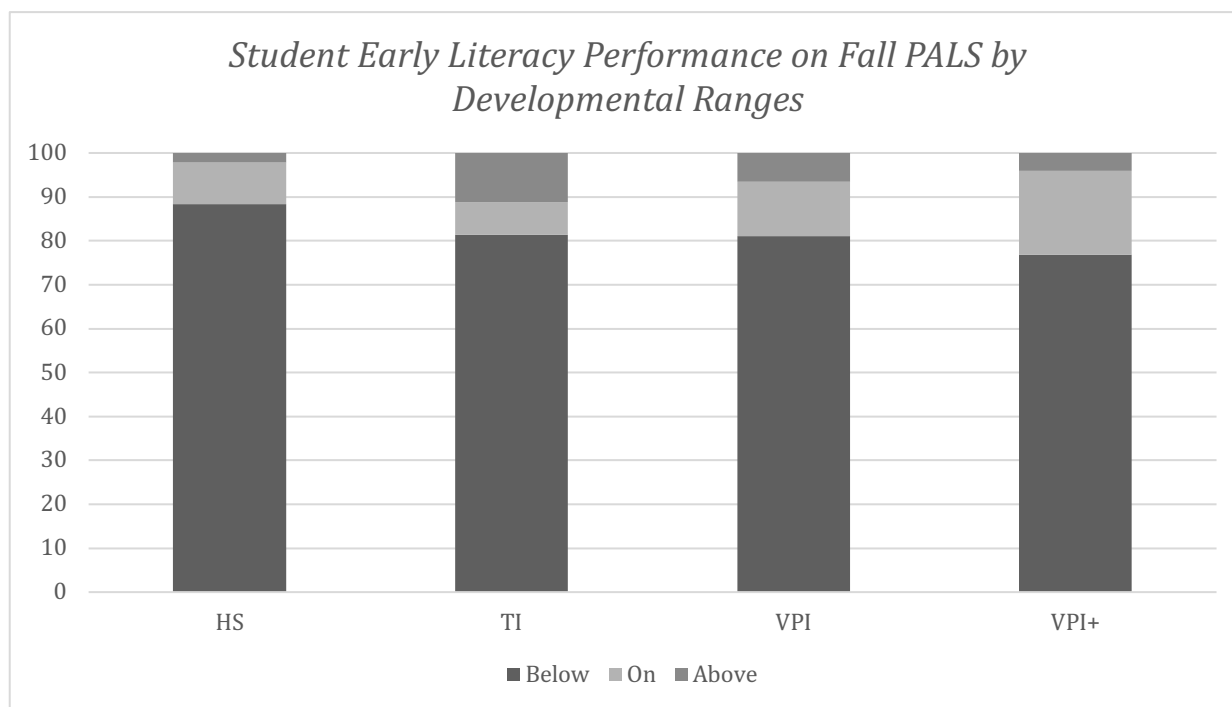


Table 16

Student Early Literacy Performance on Fall PALS by Developmental Ranges

Pre-K Program/ Intervention	Below Developmental	Within Developmental	Above Developmental	Total Students
Pre-K Total	446 / 82.3%	67 / 12.4%	29 / 5.6%	542
Head Start	158 / 88.3%	17 / 9.5%	4 / 2.2%	179
Title I Pre-K	87 / 81.3%	8 / 7.5%	12 / 11.2%	107
VPI	85 / 81%	13 / 12.4%	7 / 6.7%	105
VPI+	116 / 76.8%	29 / 19.2%	6 / 4%	151

Students exiting the four pre-k programs after completion of an entire year of participation all demonstrated growth with the exception of one student, who was removed as an outlier. Exiting the pre-k school year, the Title I Pre-K program maintained the highest percentage of students falling within the *above* range at 83.2%. Similarly, VPI+ continued to have the least amount of students within the *below* range accounting for 4.6% of students. The Head Start and VPI programs' students completed the school year with 86.6% and 83.8% *on* or *above* level, an increase of 74.9% and 64.2% respectively. Figure 6 and Table 18 more fully detail students' exiting status as it relates to the developmental continuum. Upon completion of the 2017-2018 school year, students enrolled within the various pre-k programs' early literacy growth, as measured on a developmental continuum, demonstrated an increase of students falling in the *on* or *above* ranges from 17.7% to 89.7%, an overall increase of 72% of students reaching the *on* or *above* developmental ranges.

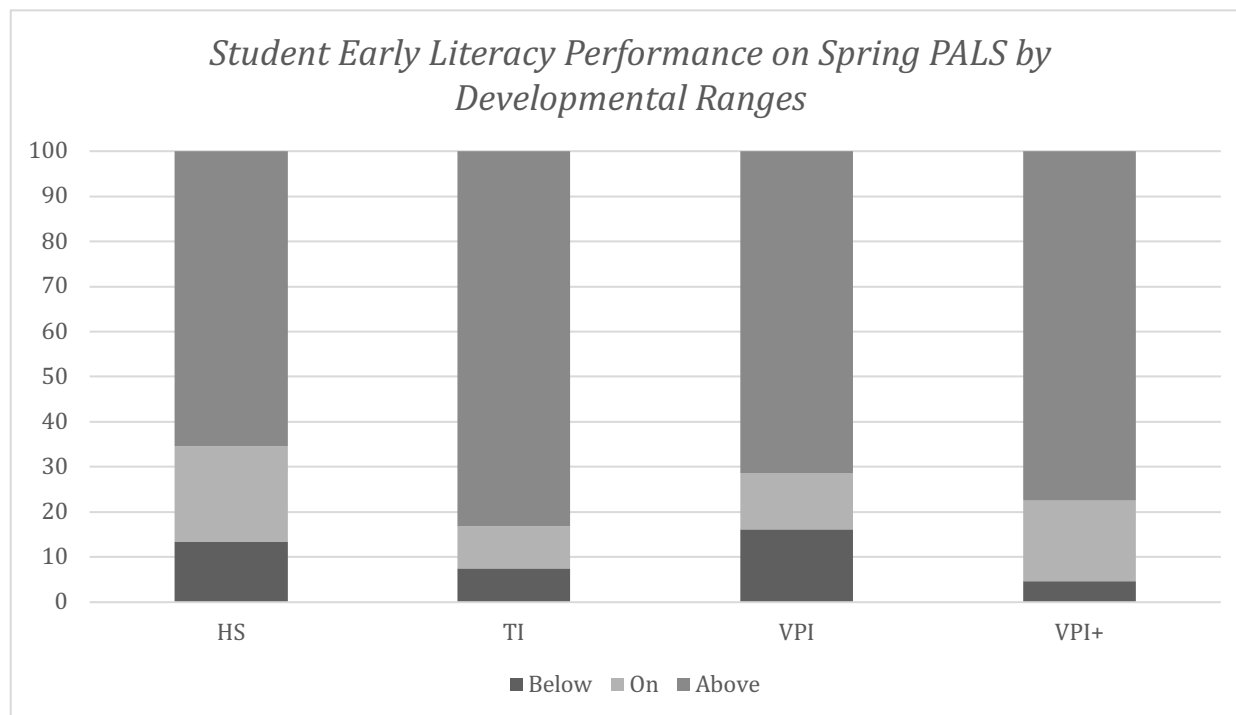
Figure 6. Student Early Literacy Performance by Developmental Ranges - Spring PALS

Table 17

Student Early Literacy Performance on Spring PALS by Developmental Ranges

Pre-K Program/ Intervention	Below Developmental	Within Developmental	Above Developmental	Total Students
Pre-K Total	56 / 10.3%	88 / 16.2%	398 / 73.3%	542
Head Start	24 / 13.4%	38 / 21.2%	117 / 65.4%	179
Title I Pre-K	8 / 7.5%	10 / 9.3%	89 / 83.2%	107
VPI	17 / 16.2%	13 / 12.4%	75 / 71.4%	105
VPI+	7 / 4.6%	27 / 17.9%	117 / 77.5%	151

Table 18

Student Early Literacy Developmental Ranges – Attainment without Above

Pre-K Program	Mean Developmental Range Attainment	Standard Deviation	Range (Min – Max)	Standard Error	Total Students
Pre-K	1.92	.698	(1 – 3)	.031	513
Head Start	1.89	.715	(1 – 3)	.054	175
Title I Pre-K	1.97	.676	(1 – 3)	.069	95
VPI	1.95	.765	(1 – 3)	.077	98
VPI+	1.89	.647	(1 – 3)	.054	145

Overall mean development range attainment was a 1.92, meaning that the average attainment was an increase of .92 from their entrance to completion of the pre-k school year. Ranges were scaled on a one to three scale. Again, as in the mean gain score analysis, there was not much variance between the programs. Head Start and VPI+ had a mean gain of 1.89 and Title I Pre-K and VPI presented with 1.97 and 1.95 respectively. Table 18 presented below provides a more detailed look at the descriptive statistics prior to reviewing the outcomes of the ANOVAs conducted.

To further investigate, one-way between subjects ANOVAs were conducted to compare the effect of pre-k program attended on students' early literacy performance, as measured by the PALS-PreK. Mean gain scores and mean developmental range attainment scores were used to conduct the analyses. There were no statistically significant differences between group means as determined by the one-way ANOVAs [$F(3, 509) = .636, p = .592, \eta^2 = .004$ and $F(3, 510) = .329, p = .804, \eta^2 = .002$ respectively]. For these reasons (no statistically significant differences, high p -value, and low effect size measured by Eta squared) three C/Es were calculated using the

mean gain score differences, the developmental level attainment differences, and with a standardized growth measure. The pre-k overall mean was used as the standardized early literacy growth score. Although the use of a standardized early literacy score across all four pre-k programs eliminates the existence of differences in performance outcomes, there remains significant differences in the cost of each pre-k program studied.

Cost

The costs for each pre-k program were derived from a review of financial documents (to include budgets, expense reports, and grants) and interviews with personnel responsible for the implementation and oversight of each program as well as personnel from the finance, benefits, budget, and grants departments. Most data used came from reports outlining actual costs. Some financial data used came from projections reported to the state and federal governments as part of grant submissions and reporting requirements. In order to make the data as comparable as possible, some standardization was necessary. Standardization included: the use of the VDOE's Online Management of Education Grants Awards (OMEGA) categories outlined in Chapter 3 to organize costs and the use of a standardized local matching, in-direct costs, or in-kind funding formula across the four pre-k programs. In the cost worksheets below, this category is listed as *Local Matching/In-Direct Costs*.

This category was standardized and created to account for the various ways that each grant incorporated local contributions. Each program had a different method to calculate or project these costs. Some programs like Title I Pre-K used a straight percentage of the overall grant as the measure of local costs, others like Head Start,

itemized Federal and non-Federal funding. To standardize these costs across the four pre-k programs, a formula used by the VPI+ grant coordinator was utilized across all four programs. This formula took the per pupil cost of the entire school system for budget categories that benefit all students and then multiplied the per pupil cost by the number of student slots in each pre-k program, or: $\text{Adopted Budget Cost} / \text{Cost per Pupil} \times \text{Number of Pre-K Program Student Slots}$. Table 19 provides an example of the funding formula, below, for one of the pre-k programs.

The categories included in this formula were: Admin/Attendance and Health, Transportation, Operations and Maintenance, Technology, and School Site Management. These accounted for costs associated with central office personnel providing Human Resources services, utility costs, rent or building usage costs such as custodial services, nurses, additional professional development not included within pre-k programs, among other general use costs. Basically, these categories account for services that employees, parents, and students receive that are not directly funded by the funding source of the pre-k program attended.

Table 19

Example of Local Matching/In-Direct Costs Category – Annual Calculation

Category	Adopted Budget	Cost per pupil/ (60,025 pupils)	Total Cost for Pre-K Enrollment by Program (x 160)
Admin/Attendance & Health	\$41,233,140	\$686.94	\$109,909.24
Pupil Transportation	\$69,240,218	\$1,153.53	\$183,650.18
Operations & Maintenance	\$110,259,072	\$1,836.88	\$293,901.74
Technology	\$27,764,654	\$462.55	\$74,008.24
School Site Management	\$71,471,320	\$1,190.70	\$190,513.00
Totals	\$319,968,404	\$5,330.60	\$868,655.91

The per pupil costs of the pre-k programs studied varied greatly from \$12,543.73 (Title I Pre-K) to \$15,944.51 (VPI+), a difference of \$3,400.78 per student, see Table 20 below. These costs are associated with additional resources and opportunities linked to the grants and development of each pre-k program as discussed in Chapter 2, Table 1. These differences can further be seen in the variances outlined on the *description* and *cost* columns on the cost worksheet tables below (Tables 21-24). Following these tables, Table 25 provides a summary of examples of additional services and opportunities offered within the pre-k programs compared to their per pupil expenditures and C/Es. It can be seen that VPI+ offers many more opportunities and services than the other programs, to include, personnel for family and community partnerships, instructional coaching, professional development, mental health, and adult education going beyond the student and the four walls of the school.

Table 20

Calculated Pre-K Program Cost per Student

Head Start	Title I Pre-K	VPI	VPI+
\$13,518.76	\$12,543.73	\$12,870.37	\$15,944.51

There are a few other considerations, which are important to note. Title I funding is allocated on an annual basis but can be spent over a longer period of time. Up to 15% of Title I funds can be carried over for an additional 12 months, with some stipulations (USDOE, 2011). Because of this, the Title I Pre-K program's overall cost included some carry over funding from the previous year's allocations and may have been slightly inflated. Additionally, lunch and breakfast may not be included for some students within the Title I Pre-K program, as the grant does not include funding for lunch and breakfast. Students enrolled in the Title I Pre-K program received lunch in the same manner as all other students. Students who did not qualify for free and reduced lunch (FRL) needed to pay for lunch or to bring lunch from home.

This has been mitigated recently, not during the time period studied, by the use of direct certification for some Title I schools. Direct certification is a process that states and LEAs follow to certify eligible children for FRL. Direct certification eliminates the need for parents to complete a FRL application. This is based upon children coming from households that already receive assistance from the Supplemental Nutrition Assistance Program (SNAP) (USDA, 2018). However, it is possible that there are still a handful of students not qualifying for FRL that need to pay.

Table 21

Cost Worksheet – Head Start

Ingredients	Description	Cost
1000 - Personal Services	Salaries – 11 Teachers, 11 Instructional Assistants, Family and Community Partnership Personnel, Program Manager and Content Area Specialist, Clerical Personnel, Director, Transportation Personnel, Home Visit Stipends, Additional Hours for Nurse	\$1,042,959.00
2000 - Employee Benefits	Disability, Unemployment (FUTA), Workers' Compensation, State Unemployment Insurance, Health/Dental/Life Insurance, Retirement, Group Life	\$424,312.00
3000 - Purchased / Contracted Services	Health / Disabilities Services, Mental Health Services	\$18,015.00
4000 - Internal Services	Child and Adult Care Food Program (CACFP)	\$24,195.00
5000 - Other Charges	Utilities, Telephone, Parent Services, Local Travel, Training or Staff Development	\$192,316.00
6000 - Materials and Supplies	Office Supplies, Child and Family Services Supplies, Food Services Supplies	\$66,242.00
Local Matching/In-Direct Cost	Admin/Attendance & Health, Pupil Transportation, Operations and Maintenance, Technology, School Site Management	\$868,655.91
Total Cost		\$2,636,694.91
Number of Participants/Average Cost per Participant	160 Student Spaces	\$13,518.76

Table 22

Cost Worksheet – Title I Pre-K

Ingredients	Description	Cost
1000 - Personal Services	Salaries – 7 Teachers, 7 Instructional Assistants, Support Personnel Temporary Work Assignments (TWAs)	\$555,102.00
2000 - Employee Benefits	Fringe Benefits for 14 Full Time Employees (FTEs), FICA for TWAs	\$212,336.00
3000 - Purchased / Contracted Services	Field Trips	\$492.34
4000 - Internal Services	Field Trip Transportation	\$125.40
5000 - Other Charges	Notary Fees, Postage, Staff Travel (Local Mileage), Staff Travel (Travel Fees and Registrations)	\$2,819.74
6000 - Materials and Supplies	Classroom Supplies, Classroom Furniture, Classroom Books and Subscriptions, Office Supplies, Chromebooks, Brigance Screener, PALS (Consumables), Snacks	\$37,633.67
Local Matching/In-Direct Cost	Admin/Attendance & Health, Pupil Transportation, Operations and Maintenance, Technology, School Site Management	\$868,655.91
Total Cost		\$1,677,165.06
Number of Participants/Average Cost per Participant	112 Student Spaces	\$12,543.73

Table 23

Cost Worksheet – VPI

Ingredients	Description	Cost
1000 - Personal Services	Salaries – 7 Teachers, 7 Instructional Assistants, Substitutes	\$556,086.36
2000 - Employee Benefits	Benefits – FICA Expense, VRS Retirement, VRS Hybrid Plan Contribution, VRS, Retiree Health Care Credit, Anthem, Health Savings Account, Dental, VRA Group Life, VRS Hybrid Disability	\$261,390.74
3000 - Purchased / Contracted Services		\$0
4000 - Internal Services	School Division Provided Meals, Field Trip Transportation, Print Shop Costs	\$8,614.53
5000 - Other Charges		\$0
6000 - Materials and Supplies	Office Supplies, Books and Subscriptions, Instructional Supplies, Software, Computer Equipment	\$19,000.66
Local Matching/In-Direct Cost	Admin/Attendance & Health, Pupil Transportation, Operations and Maintenance, Technology, School Site Management	\$868,655.91
Total Cost		\$1,713,748.20
Number of Participants/ Average Cost per Participant	112 Student Spaces	\$12,870.37

Table 24

Cost Worksheet – VPI+

Ingredients	Description	Cost
1000 - Personal Services	Salaries – 10 Teachers, 10 Instructional Assistants, VPI+ Grant Specialist, Family Engagement Coordinator (Part-Time), 2 Instructional Coaches, Budget Personnel/Office Manager (Part-Time), Substitutes, Translators/Interpreters, Application Assistants, Home Visit Stipends	\$1,062,180.00
2000 - Employee Benefits	Benefits and FCIA	\$389,281.71
3000 - Purchased/ Contracted Services	SRI Program Evaluation and Summative Assessment, PALS, TS GOLD Maintenance Contract, CLASS Library/Teachstone/PATHS, Registration (Staff Travel), Field Trips, Virginia Early Childhood Foundation	\$155,920.52
4000 - Internal Services	Mental Health, Adult Education Classes (ESOL), GED Classes, Snacks, School Division Provided Meals, Field Trip Transportation, Print Shop	\$19,951.00
5000 - Other Charges	Staff Travel (Local Travel), Staff Travel (Travel Fees and Registrations), Cell Phones, Postage, Indirect Costs	\$45,048.87
6000 - Materials and Supplies	Family Engagement Supplies, Classroom Supplies, Office Supplies	\$10,082.90
Local Matching/In-Direct Cost	Admin/Attendance & Health, Pupil Transportation, Operations and Maintenance, Technology, School Site Management	\$868,655.91
Total Cost		\$2,551,120.91
Number of Participants/ Average Cost per Participant	160 Student Spaces	\$15,944.51

Table 25

Examples of Additional Services and Opportunities Offered within Pre-K Programs Compared to Per Pupil Expenditures and C/Es

Pre-K Program	Examples of Additional Services and Opportunities Offered	Annual per Pupil Cost	Cost-Effectiveness Ratio using Standard Measure
Head Start	Additional School Nurse hours, Community partnership personnel, dedicated director, breakfast, lunch, and snacks, home visits	\$13,518.76	\$203.05
Title I Pre-K	Family Engagement Coordinator (not dedicated to only pre-k programs but all of Title I schools), snacks, home visits	\$12,543.73	\$188.40
VPI	Breakfast, lunch and snacks, home visits	\$12,870.37	\$193.30
VPI+	Grant Specialist, Smaller class sizes, part-time Family Engagement Coordinator, formative assessment resources, additional coaching and professional development, mental health supports, adult education classes (ESOL and GED), breakfast, lunch, and snacks, home visits	\$15,944.51	\$239.48

Cost-Effectiveness Analysis

It was initially planned to conduct a single CEA using the common measure of a PALS-PreK gain mean score to determine the cost-effectiveness of four pre-k programs in increasing early literacy performance. As discussed earlier, concerns related to the findings showing no statistically significant differences between the programs, high p -values, and low effect sizes measured by Eta squared, led to the use of multiple CEAs. CEAs were conducted using the mean gain score differences, the developmental level

attainment differences, and with a standardized growth measure (the overall pre-k mean gain score).

Findings from the CEAs conducted all found the Title I Pre-K program to be the most cost-effective program with the highest performance growth. In comparing the mean gain scores, the Title I Pre-K program had the highest mean gain score at 69.36 and the lowest C/E of \$180.85. The VPI+ program had the second highest mean gain score at 66.37 but at a cost of \$240.24 per mean gain score point increase. Similarly, in the developmental range attainment analysis, the Title I Pre-K program had the highest developmental range attainment at .97 for a cost of \$6,363.38 per developmental range increase. Head Start and VPI+ had a mean developmental range attainment of .89, a lower effect, albeit minimal, at a cost of \$7,152.78 and \$8,436.25 respectively. Using the standard measure of the PALS-PreK mean gain score across all programs, the Title I Pre-K program remained the most effective at \$188.40 per unit of increase in PALS-PreK mean gain score. See Tables 26 through 28 below.

Table 26

Cost-Effectiveness Analysis of Four Pre-K Programs – Mean Gains

Pre-K Program/ Intervention	C - Cost per Student per Year	E - Effect on Early Literacy Growth (PALS Pre/Post)	C/E Cost-Effectiveness Ratio
Head Start	\$13,518.76	66.26	\$204.03
Title I Pre-K	\$12,543.73	69.36	\$180.85
VPI	\$12,870.37	64.76	\$198.74
VPI+	\$15,944.51	66.37	\$240.24

Table 27

Cost-Effectiveness Analysis of Four Pre-K Programs – Developmental Range Gains

Pre-K Program/ Intervention	C - Cost per Student per Year	E - Effect on Early Literacy Growth (PALS Pre/Post)	C/E Cost-Effectiveness Ratio
Head Start	\$13,518.76	.89	\$7,152.78
Title I Pre-K	\$12,543.73	.97	\$6,367.38
VPI	\$12,870.37	.95	\$6,600.19
VPI+	\$15,944.51	.89	\$8,436.25

Table 28

Cost-Effectiveness Analysis of Four Pre-K Programs – Standard Measure of Growth

Pre-K Program/ Intervention	C - Cost per Student per Year	E - Effect on Early Literacy Growth (PALS Pre/Post)	C/E Cost-Effectiveness Ratio
Head Start	\$13,518.76	66.58	\$203.05
Title I Pre-K	\$12,543.73	66.58	\$188.40
VPI	\$12,870.37	66.58	\$193.30
VPI+	\$15,944.51	66.58	\$239.48

Summary

The results of this study suggest that early literacy growth does not vary much, if at all, between the pre-k programs studied, but that there are differences in the costs associated with each program. Findings pertaining to the measure of effect, PALS-PreK, should be viewed with caution when considering generalizing to similar populations or programs. Multiple statistical approaches were attempted to fully look at early literacy growth to include attempts to mitigate the limitations of using PALS-PreK data. These methods included the elimination of participants skewing the data by entering pre-k with a score in the end of year developmental range of *above*, using developmental levels in addition to mean gain scores, and using a standardized performance score.

The review of financial data demonstrated vast differences in per pupil expenditure between the pre-k programs offered. These differences were directly related to the inclusion of additional services and opportunities that sometimes reached beyond the school to include parent and community partnership personnel and parental educational opportunities like GEDs and English classes, see Table 25 above. Similar to the review of financial data, the CEA findings suggest that there are differences in the cost of pre-k programs. And, after conducting multiple CEAs, the findings suggest that early literacy performance may not be related to the per pupil cost of the pre-k program attended. This is not to say that there are no long-term benefits or that there are no other benefits related to the pre-k program attended. Certainly, the additional supports and opportunities provided in the more expensive programs, like VPI+, could have

beneficial effects on school readiness factors other than early literacy, factors such as health, social-emotional development, and mathematical reasoning.

Chapter 5: Conclusions, Discussion, and Suggestions for Future Research

Introduction

Building off of assumptions from the research that pre-k programs have positive academic and financial benefits, this study sought to determine the early literacy growth of students in relation to the per pupil cost of each of the four pre-k programs offered within a large school system in central Virginia. Data used from the 2017-2018 school year revealed vast differences (related to a myriad of opportunities, services, and supports) in the overall funding of the four programs offered. This research was timely as the United States Department of Education's Preschool Development Grant (PDG), which funded the VPI+ pre-k program, expired at the end of the 2018-2019 school year. Additionally, during 2018 there were a number of executive and legislative actions concerning initiatives, like pre-k programs, that addressed school readiness. This combination of political desire and the expiration of significant pre-k funding was an opportune time to consider the costs, performance, and effectiveness of pre-k programs in Virginia.

PALS-PreK data was used as a common measure of effect of early literacy performance, as it was available for all programs. Combined with the financial figures, this data was used to conduct several cost-analyses looking for effectiveness in relation to cost. As stated in the findings of Chapter 4, it is important to note that my results do not suggest a lack of longer-term benefits or other benefits related to pre-k program attendance. After a summary of the findings, I will present a discussion on implications for practice, discuss limitations of the study, and, based on these limitations, suggest recommendations for future research.

Summary of Findings

To discuss the early literacy growth of students in relation to the per pupil cost of each pre-k program studied, several changes to the methodology occurred over the course of the study. The PALS-PreK data was looked at in various ways to determine if there were differences in the early literacy growth of students between the pre-k programs. The data was analyzed using two ANOVAs looking at mean gain score increases and developmental level attainment. After struggling to find variance between the programs³, an overall mean score was included in the CEA. Findings are presented below, organized by the three research questions posed:

1. Are there differences in students' PALS growth based upon the pre-k program attended?
2. What is the cost of delivering pre-k education by program?
3. What is the cost-effectiveness, as measured by early literacy growth, of pre-k programs offered within the school system being studied?

Early Literacy Growth. The first research question asked if there were differences in students' early literacy growth based upon the pre-k program attended. A comparison of mean gain scores revealed a 4.60-point difference across the programs, suggesting that early literacy student performance between pre-k programs does not differ greatly within the population studied. Title I Pre-K had the highest mean gain score at 69.36, followed by VPI+ at 66.30, Head Start at 66.26, and VPI at 64.76.

In the developmental range attainment analysis, the overall mean attainment was .92. Similar to the mean gain score analysis, there was not much variance between the

³ Issues with finding variance was related to limitations associated with the use of the PALS-PreK as a growth measure.

programs, a difference of only .08 between programs. Head Start and VPI+ had a mean gain of 1.89 while Title I Pre-K and VPI presented with 1.97 and 1.95 respectively. It is important to note that these differences represent the population studied.

Costs. The second research question looked at the cost of delivering pre-k education by program. Findings from interviews and a review of financial documents found that the per pupil costs of the pre-k programs studied varied greatly from \$12,543.73 (Title I Pre-K) to \$15,944.51 (VPI+). Additionally, the review of costs supported the association of additional costs to the availability of additional resources and opportunities.

Cost-Effectiveness. The final research question asked the cost-effectiveness, as measured by early literacy growth, of pre-k programs offered within the school system being studied. Due to concerns related to the early literacy gains outcomes (no statistically significant differences, high p -values, and low effect sizes measured by Eta squared)⁴ three C/Es were calculated. CEAs were conducted using the mean gain score differences, the developmental level attainment differences, and with a standardized growth measure. All CEAs conducted found the Title I Pre-K program to be the most cost-effective program with the highest performance.

Conclusion. As stated in Chapter 4, the results of this study suggest a lack of difference in early literacy growth attainment between the pre-k programs studied and a significant difference in per pupil expenditure associated with each program. Differences in per pupil expenditure were related to the inclusion of additional supports and

⁴ Since I studied the entire population, inferential statistics were not necessary to make conclusions concerning this population. However, to generalize to similar populations in different school systems, inferential statistics allowed me to reflect upon what these findings meant beyond the school system studied.

opportunities offered by the different programs, some of which can be seen in Table 25 located in Chapter 4. As this was a CEA with the intent to determine the most cost-effective pre-k program in attaining an acceptable level of student early literacy performance, this study found the Title I Pre-K program to be the most cost-effective (lowest cost with highest gains) in all three analyses. However, findings should be viewed with caution as the ANOVAs conducted on the mean gain scores and developmental range attainment failed to find statistical significances. Generalizing beyond the school system studied, I would conclude that there were no differences in achievement. If achievement is the only measure of effectiveness, then the program that had the lowest cost would be the most effective. Additionally, these findings do not consider longer-term benefits on early literacy or other benefits related to potential effects on school readiness factors such as health, social-emotional development, and mathematical readiness. These will be further discussed in the Limitations and Recommendations for Future Research section below.

Implications for Practice

Implementation of programs and services comes at a cost. Affluent or impoverished, funding is not infinite and school systems must make decisions pertaining to the educational opportunities provided based upon the needs and priorities of their communities. The use of economic evaluations like CEAs and CBAs can assist in making informed decisions pertaining to the benefits of enacted initiatives. Additionally, the use of economic evaluations in education provides transparency and accountability related to the spending of public funds. Simply put, the use of economic evaluations allows school systems to spend public funds diligently and responsibly.

Findings from this study provide some insight into the performance of pre-k programs on early literacy growth and the cost to attain said growth. As the research (JLARC, 2007; Phillips et al., 2017; Schweinhart, 1993; Schweinhart, 2004; U.S. Department of Health and Human Services, 2010) has shared, quality pre-k opportunities increase formal school readiness, specifically in the areas of early language, literacy, and mathematical development. Even though the purpose of this study was not to determine the value of pre-k programs in preparing students for school, this assumption was part of the theoretical framework this study was based upon, findings from this study support these previous findings. In this study, 89.6% of students enrolled in the pre-k programs studied exited pre-k on or above the PALS-PreK established developmental levels. This is significant growth considering that only 18% of students entered pre-k in the *on* or *above* developmental levels and that the Virginia Kindergarten Readiness Program (VKRP) reported that in 2019 only 56.2% of students across the Commonwealth of Virginia entered kindergarten meeting the criteria of school ready. The VKRP definition of school readiness includes early literacy readiness in addition to Social Skills, Mathematical, and Self-Regulation readiness (VKRP, 2017). Participation in a pre-k program has an effect on student readiness for kindergarten.

Since space within pre-k programs is limited and several of the pre-k programs studied had lengthy waiting lists of students desiring the opportunity to attend, it may be advantageous to consider administering the PALS-PreK as part of the registration process and selection criteria. Currently, students are selected for inclusion in the pre-k programs based upon multiple ranked factors to include household income, a school readiness screener, and the identification of disabilities. This helps ensure that the

students with the greatest need have priority of acceptance; however, if the purpose of the pre-k programs is to increase school readiness, the use of the PALS-PreK during the selection process may provide more detailed data to assist in the selection process.

Findings from this study found that 98 students entered pre-k on (n=69) or above (n=29) the end of year developmental level as measured by the October, 2017, administration of the PALS-PreK. More detailed selection criteria may assist in ensuring that the students with the greatest need are accepted first. Constraints related to the time necessary to complete the PALS-PreK may make this a challenging suggestion. This study did not find that there were students of less need accepted over those of greater need. This discussion arises merely from the recognition that there are more students than space within the school system studied and that upon entrance into the pre-k intervention, 98 students entered with in the *on* or *above* early literacy developmental levels. Early literacy is only one measure of school readiness, it is possible for students' school readiness to differ across the various areas that frequently encompass school readiness, meaning that a student may be school ready in early literacy but not in socioemotional or mathematical readiness.

Results of this study support that efforts by the school system studied to standardize the pre-k programs offered may not negatively impact the early literacy performance of students as early literacy performance did not vary much across the programs. As discussed earlier, within the school system studied, there have been recent efforts to make all pre-k programs look the same in what they offer students and families. However, I recommend, based upon this study, that prior to deciding the model

of pre-k program to offer as the standard, a more detailed analysis should be considered to assess impacts to other areas of school readiness development.

Broader implications for practice center around calls for increased pre-k opportunities and universal pre-k, which is the availability of pre-k programs to all children regardless of factors. If a state or school system were considering increased pre-k programs or universal pre-k, it would be judicious for legislators and other decision makers to explore the results of economic evaluations like this one in considering the model and funding of such initiatives.

Limitations and Recommendations for Research

As with all research there are limitations within this study. Responsible scholarship includes thoughtful reflection on the implications of the research and of the findings; this is especially important when considering limitations related to this study. Results and the methodology used to find them have been presented in a transparent manner throughout this study. This section reflects upon the limitations of this study and discusses recommendations for future research, some of which derive directly from the limitations discussed.

The use of the PALS-PreK as a growth measure posed difficulties in comparing students' early literacy growth. This is partially related to the manner in which the assessment is scored. The PALS-PreK is made up of eight subtests. Each subtest has a maximum set of available points assigned. These points range from 7 to 26 with a total of 125 points available. Even though the PALS-PreK does not have established beginning of the year developmental ranges, since students are not expected to enter pre-k with any of the early literacy skills measured, students enter at varying levels,

sometimes even at a mastery level. This resulted in some compression of the scores. Students entering with high scores, showed less growth because they already attained a majority of the points, there were no points left to show growth.

Multiple statistical approaches were attempted to fully look at students' early literacy growth. Because this was a study on an entire population, it was not necessary to analyze difference using inferential statistics. Whatever differences there were among programs – and there were differences, although very small – were real. However, because I also wanted to be able to generalize beyond the school system and the population studied, I also compared growth across programs using inferential statistics to be able to infer findings to similar populations. Ultimately, no statistical significance was found in the two ANOVAs conducted resulting in the use of a standardized pre-k score for the CEA. This is not surprising as the PALS-PreK was not designed as a growth measure, it was designed as a tool for gathering formative data with the intent of informing instruction and lesson design (PALS, 2019). As a reminder, PALS-PreK data was used because it was the only common measure of early literacy available across the pre-k programs studied, it allowed for a pretest/posttest analysis because it was given in the Fall and Spring, the Spring administration had established developmental ranges that are predictive of future reading success (PALS, 2019), it has acceptable reliability and validity (Invernizzi et al., 2004), and because it has been used in previous implementation and performance evaluations of pre-k programs like VPI and VPI+ (JLARC, 2015). Future research could explore the use of different assessments that measure early literacy growth. Use of a different assessment may find larger, and

statistically significant, differences among programs. A battery of additional outcomes beyond early literacy growth might also be helpful in weighing costs to outcomes.

Additionally, an analysis of the data across racial, ethnic, socioeconomic, and gender groups may produce findings showing differences between groups. When looking at the demographic data presented, sub group codes were a limitation of this study as the PALS-PreK data presented race and ethnicity as separate codes and the VDOE categories were reported as a single combined race/ethnicity code (example: White, not of Hispanic origin). As racial and ethnicity classifications are parent selected and parent reported, it is possible that the demographics presented in this study may be slightly misrepresented.

When creating the standardized demographic information by removing students reporting as Hispanic from their other reporting indicators (if a student was identified as Hispanic and white within the PALS-PreK dataset, they were coded as Hispanic and removed from the white reporting category count), it is possible that students were coded contrary to what parents would have chosen. As the VDOE demographic information did not further differentiate the Hispanic reporting characteristic into white Hispanic and black Hispanic, it was not possible to convert the VDOE data into two corresponding reporting categories of ethnicity and race similar to the PALS-PreK dataset. Because an analysis was not completed looking at differences between sub groups, this limitation only relates to the presentation of the comparison of the demographics at the state, school system studied, and pre-k program levels.

Finally, this study was limited in only including one school readiness factor over a one-year period. A look at longitudinal outcomes across students' formal schooling

could provide a more comprehensive understanding of long-term effects and costs of the pre-k programs attended. A study looking at longitudinal outcomes could continue to use PALS data as PALS is used in Virginia public schools up to grade three. A study like this could also include a comparison of students who did not attend one of the pre-k programs as PALS data would be available for those students as well. Furthermore, this study could be expanded to look at additional school readiness factors. The recent partnership between the University of Virginia, the Virginia Department of Education, and the school systems across the Commonwealth to create a comprehensive school readiness assessment (VKRP, 2017) could be an opportunity to compare students' performance across various school readiness factors.

During the 2019-2020 school year Virginia school systems began using the Virginia Kindergarten Readiness Program (VKRP) to assess kindergarten students across the Commonwealth. The VKRP is a comprehensive school readiness assessment that includes PALS as a measure of early literacy readiness, in addition to measures of mathematics, self-regulation, and social skills (VKRP, 2017). The mission of the VKRP is to provide a comprehensive picture of student's skills at kindergarten and beyond (VKRP, 2017), a mission that is in line with the rationale behind this study.

Conclusion

In conclusion, this study sought to examine four pre-k programs offered within a large school system in Virginia to determine if there were differences in students' early literacy growth by program attended and evaluated the ratio of cost to achievement of each pre-k program to determine their cost-effectiveness. To do this, this study built upon the academic research supporting that student early literacy readiness is

predictive of later academic success and that pre-k programs are a proven intervention in developing early literacy. Additionally, it was recognized that the cost of pre-k programs differed greatly given the varying array of opportunities and services provided within each program.

A detailed analysis of the pre-k programs' services, costs, and performance was conducted to determine the cost-effectiveness of each program. Results found small differences in the population studied; however, in generalizing beyond the population studied there were no statistically significant differences between group means in either of the analyses conducted, [$F(3, 509) = .636, p = .592, \eta^2 = .004$ and $F(3, 510) = .329, p = .804, \eta^2 = .002$]. Although this study did not find significant differences in students' early literacy performance between pre-k programs, it did reveal significant differences in the overall costs and opportunities provided of pre-k programs studied. Using a standardize growth measure, CEA results found the Title I Pre-K program to be the most cost-effective, meaning that the Title I Pre-K program had the lowest per pupil expenditure with highest early literacy gains.

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J. G. Hening Elementary School, Chesterfield, VA. Chesterfield County Public Schools
Responsibilities: Serves as an instructional leader of a large (900+ students) Title I school; uses data to lead the school efforts in achieving high academic performance of all students; provides an environment that maximizes the learning potential of all students and employees. Analyzes and interprets data to determine instructional focus of the school; ensures programs and strategies are in place for enrichment and remediation services for all students. Provides leadership and direction to assistant principals, teachers and support staff. Coordinates curriculum development with instructional services, administrators, specialists, and teachers. Evaluates staff according to school board policy. Provides ongoing staff development relative to the school board's vision and mission, school goals, and school improvement and innovation initiatives. Interprets School Board policies, procedures, and guidelines to parents and public. Ensures compliance with existing applicable federal and state statutes, policies and guidelines related to public schools and in particular the operation of programs for the academically talented and special education. Works in collaboration with the Department of Instructional Technology in providing appropriate technology opportunities to enhance student learning. Coordinates with the Human Resources Department concerning staffing needs; recommends staffing changes; participates in the recruitment, selection, and assignment of staff. Responsible for budget preparation. Monitors school and activity fund budget status throughout the year. Works with the Office of Student Conduct to analyze data on student conduct and to resolve student, school, and district issues regarding student discipline.

Assistant Principal**August 2011-2015**

Swift Creek Elementary School, Midlothian, VA. Chesterfield County Public Schools

Responsibilities: Served as an instructional leader using data to lead the school's efforts in achieving high academic performance of all students; provided an environment that maximized the learning potential of all students and employees. Analyzed and interpreted data to determine instructional focus of the school. Evaluated staff according to School Board policy. Provided ongoing staff development relative to the School Board's vision and mission, school goals, and school improvement initiatives. Worked with the Office of Student Conduct to analyze data on student conduct and to resolve student, school, and district issues regarding student discipline. Assessed student learning and altered instruction to meet group/individual needs. Used the curriculum of the district to plan daily instructional activities. Served as the: Testing coordinator, Administrator of Special Education, and as the 504 Coordinator. Cofounder of The Great Gator 5K.

Teacher**August 2007-2011**

Bon Air Elementary School, Richmond, VA. Chesterfield County Public Schools

Responsibilities: Taught first and third grades general education. Instructed all academic subjects. Cofounder of the Bon Air Elementary School 5K run. Cofounder of the Bon Air Elementary School Children's Choir. Member of the school leadership team. Member of the child study intervention team. PTA faculty liaison. Member of the school improvement team. Team leader. Teacher of the Year 2010-2011.

Quality Assurance Officer, United States Army Reserve**August 2007-2008**

7th Battalion, 3rd Brigade, 94th Division, 80th TASS (IT), Fort Eustis, VA

Responsibilities: Provided guidance and oversight to a Total Army Schools System Battalion with an authorized strength of 86 Soldiers and civilians, geographically dispersed across the United States, instructing five Military Occupational Specialty schools. Ensured the Battalion maintained accreditation and taught using the Army standards of instruction. Ensured Soldiers were highly trained by conducting evaluations and instructor observations.

Academic Instructor**July 2006-2007**

Central Texas College, Europe Campus, Camp Arifjan, Kuwait

Responsibilities: Provided Advanced Skills Education Program (ASEP) instruction to Soldiers. The purpose of the instruction was to enhance communication, management, and supervisor skills of personnel.

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Southampton Model Elementary School, Richmond, VA. Richmond City Public Schools.

Responsibilities: Taught fourth grade general education in a Title I school. Instructed all academic subjects in an inclusion setting. Lead Social Studies teacher for the school.